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THE GORGONACEA
WITH NOTES ON TWO SPECIES OF PENNATULACEA

BY THE LATE

PROFESSOR SYDNEY J. HICKSON, F.R.S.

WITH ONE PLATE AND TWELVE TEXT-FIGURES

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INTRODUCTION.

As the marine fauna of the Indian Ocean has been already investigated by the naturalists associated with the "Valdivia", "Investigator" the Pearl Fisheries, the "Percy Sladen" and other expeditions it was not expected that the collections of the "Murray" Expedition would bring to light many new or specially interesting species.

Only two new species of Gorgonacea have been added to the long list of species that have already been described. One of these, *Acabaria mabahissi*, was found off Cape Guardafui, and is in many characters absolutely distinct from all the other species of its genus. There were five specimens in the collection showing considerable variation in the form of the corallum and in colour, but none of these varieties show any approach to the characters of other species. It is, in fact, quite discontinuous with other species, and, so far as is known at present, confined to this one locality off Cape Guardafui.

Some of the most striking features of the growth form of these colonies are probably due to the activities of symbiotic Crustacea. One of these, found loose in the bottle, was identified as a species of *Uroptychus*, but another one, probably belonging to the same species, was found—and remains—imprisoned in the meshwork of the branches of the flabellum.

The other new species, *Stenogorgia sewelli*, differs from other species of the genus by the enormous size of its spindle-shaped spicules. This is, of course, a very variable character and standing by itself it is not a very reliable one for specific diagnosis. It is possible that in this respect intermediate varieties will be found between the new and older species ; but taking into consideration several other characters of minor importance I think the constitution of *St. sewelli* as a new species is justified.

In my report on the Pennatulacea (1937*b*, p. 109) I remarked that a feature of special value in the Murray collection was the presence of a large number of specimens of some of the species as affording an opportunity for the study of variations. In the Murray collection of Gorgonacea four species are represented by several or many specimens. One of these, which I have referred to the species *Chrysogorgia flexilis*, is represented by several large specimens and numerous fragments from six stations at depths of 229–1450 metres. A careful examination of preparations of the polyps of several branches of a single large colony and of most of the other specimens and fragments from the same and different colonies has shown so much variation in the size of the polyps and the characters of the spicules that the specimens must be regarded as examples of one widely distributed deep-sea species.

Another species of the same genus, *C. cupressa*, is represented by 70 specimens of various sizes from one locality. The characteristic " bottle brush " form of the colonies is common to all of them, and in other characters there is comparatively little variation. The general conclusions are, therefore, that *C. cupressa* is a perfectly distinct species and that the only other species of the genus in the Indian Ocean is *C. flexilis*.

Another result from the investigation of these specimens is to throw considerable doubt on the validity of Versluys' genus *Metallogorgia* (p. 308).

The discovery of two specimens of *Solenocaulon ramosum* at Station 24 off Cape Guardafui is also of some special interest. They are almost identical in size and other characters with the type specimen from the Maldive Archipelago, which I described nearly forty years ago.

The peculiar belt-like outgrowths of the stem of this species (see Text-fig. 1) were considered to be gall-like structures due to the activities of some epizoic crustacean. This view has been contested by other authors, and one of them definitely asserts that they are essentially " inherent characters of *Solenocaulon* " and have nothing to do with crustacean epizoites.

This interesting problem is fully discussed on p. 271.

I have again to thank Col. Sewell and Capt. A. K. Totton for much valuable advice and assistance, and also Prof. J. Gray for allowing me full facilities to work in the Zoological Department of the University of Cambridge.

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Order GORGONACEA.

Sub-order SCLERAXONIA.

Family Briareidæ.

Solenocaulon ramosum Hickson (1900*b*, p. 498). (Text-fig. 1.)

There are two specimens and some fragments of this species from Station 24, 73–220 metres, off Cape Guardafui.

They are 250 and 270 mm., respectively, in length, and they have a solid, unbranched

stalk 60–68 mm. in length. The base of attachment of both of them is unfortunately missing.

Above the stalk there are five belts in each specimen, 20–30 mm. in length and 10–20 mm. in diameter. These tubular belts are nearly all complete, that is to say, the two wing-like outgrowths from the main stem are fused together at their free edges to form a short wide tube with a large aperture at both ends.

From the free edges and along the line of suture of the belts numerous branches of various lengths arise bearing a large number of polyps. These branches are flattened or deeply grooved on one side, or solidly cylindrical according to their length.

According to a note made by a naturalist on board the ship, these specimens were, when alive, white with pink polyps.

The preserved specimens are all brown in colour and it seems probable, as there are no pink or red spicules in any of my preparations, the pink colour of the living specimens is due to one of those soluble colouring matters that are so frequently seen in living Alcyonaria. The brown colour of the preserved material may be due to a thin deposit of mucus which spreads all over the colonies.

In all these characters and in many others these specimens, from a depth of 73–220 metres off Cape Guardafui, agree very closely with the type specimen from 71 metres from Suvadiva atoll in the Maldive Archipelago, which I described and illustrated in 1900*b* (p. 498, pl. xxvii). Since the original description of the species was published there has been a good deal of severe criticism about its validity.

The characters of the spicules do not differ materially from those of other species of the genus and the fact that in the type specimen the polyps were less contracted than in any of the others was considered by Thomson and Simpson (1909, p. 154) to be " a matter of little importance ".

The only other distinguishing feature of the species therefore is the presence of the broad belts which I believed to be due to the activity of an epizoic crustacean.

In my original description I expressed some hesitancy in constituting a new species for it on the ground that, as there was only one specimen to examine, intermediate forms might be found between the tubular formations of other species of the genus and the belts of *Solenocaulon ramosum*. Such intermediate forms, however, were not found in any of the eleven specimens of the genus in the collection from the Maldives.

Miss Harrison (1908, *a* and *b*, p. 39) described a specimen of *S. ramosum* from the Bay of Bengal which was 850 mm. in length and bore six incomplete and three complete belts and was said to agree in all points with the type except in its great size and entire absence of colour. It is unfortunate that neither the exact locality nor the depth from which this specimen came are recorded.

The greater number of belts may also be considered as a point of difference between her specimen and the type.

As we have now three more specimens showing the same essential characters as the type, the species is no longer known by the character of a solitary specimen. Moreover, as the four specimens were found in three localities 1000 miles or more apart the species cannot be regarded as a purely local variation. The principal difficulty, therefore, in regarding *S. ramosum* as a good species is removed.

The character that the polyps are less contracted than they are in any other species of the genus that I have examined may be a matter of little importance, but it is interesting

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that it is the same in all the new specimens as well as in the type, and is due to the spicules of the crown and points being more numerous, more closely set and thicker than in any other species (Hickson, 1900*b*, p. 499).

It is true that in the form of the spicules and in other anatomical features there is very little to distinguish *S. ramosum* from the other species of the genus, and therefore the significance of the belt becomes a matter of the greatest importance.

These large wide belts are only found in *S. ramosum*, although in other species of the genus long, irregular or interrupted tubes and foliate expansions are of frequent occurrence. In my original paper I expressed the opinion that they are gall-like structures due to the activities of epizoic Crustacea.

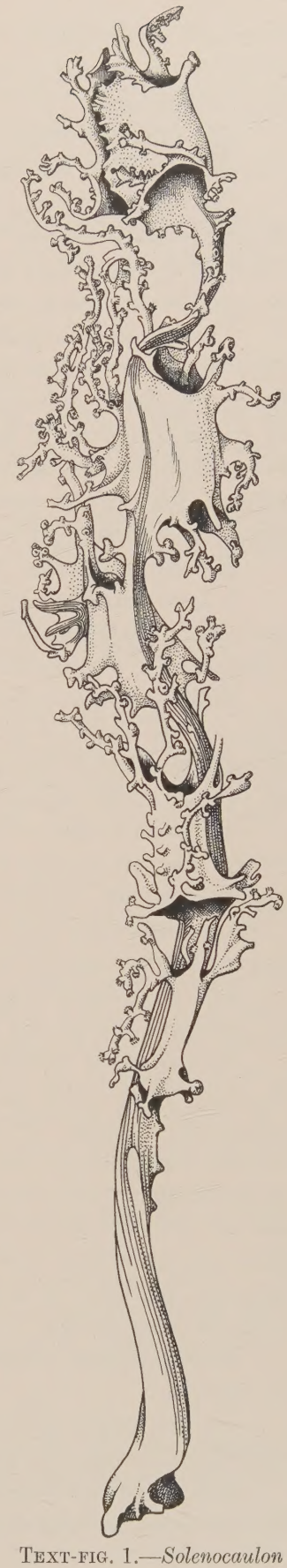
Stiasny, however, in a recent paper (1937, p. 195) declares that the belts, tubes and similar structures are inherent characters and have nothing to do with crabs. They are not, according to his view, pathological, but perfectly normal structures.

It is not necessary to discuss here the seven reasons he gives in support of his opinion because the evidence that they are gall-structures seems to be overwhelming. I will only refer to some facts that have been described since 1900, which throw important light on the problem.

In the new species *Acabaria mabahissi* (p. 274), also from the Murray Station 24, there is a tubular stem and wide irregular spaces between the two fan-shaped expansions of the branching part of the colonies, and there are grooves on many of the secondary branches. The internal surface of all these spaces and the concave surfaces of the grooves are all quite smooth and present a general resemblance to the similar surfaces of *Solenocaulon ramosum*. A specimen of the Galatheid crab *Uroptychus* was found free in the bottle and another crab belonging, probably, to the same species was and remains imprisoned in the flabellum. It is true that no crab has been found *in situ* in any specimen of *Solenocaulon ramosum*, but considering the fact that the belts of this species have a wide aperture at both ends it would be very surprising if any crabs that might have been there did not escape as they were dragged up from great depths of the ocean and then emptied out on to the deck of the steamer.

In other species of Solenocaulon symbiotic Crustacea have been found. Nutting (1911) says of a species he refers to *S. sterroclonium* (p. 5) that "the passages are inhabited by a Macruran crab" and of a *S. jedanense* (p. 10) "some of the specimens bear symbiotic Brachyuran crabs".

It is well known to carcinologists that several species of



TEXT-FIG. 1.—*Solenocaulon ramosum.*

Crustacea are symbiotic or associated with Alcyonaria, and among the notes on stations made by the naturalists of the John Murray Expedition there are several that mention such associations.

The influence that symbiotic Crustacea may have on the growth of both hard and soft parts of other Alcyonaria may be seen in the following examples :

Gravier (1914, pp. 34 and 99) described gall-like excrescences on *Primnoisis* and *Mopsea gracilis* caused by the Lamippid crustacean *Isidicola antarctica* and Versluys (1902, p. 4) relates that in the large polyps of *Chrysogorgia cupressa* inhabited by Copepods the spicules are more numerous and much larger than in polyps that are not so infected.

The formation of gall-like structures in other groups of Cœlenterata are not uncommon. The well-known cages of Seriatopora and Pocillopora are undoubtedly formed by and finally imprison the females of *Hapalocarcinus marsupialis*. The formation of these cages in a large specimen of Seriatopora can easily be studied. In the early stages there are two wide-open leaf-like expansions—similar to the early stages in the formation of the belts of *Solenocaulon ramosum*—which turn inwards with the growth of the corallum and fuse at their free edges to complete the closed cage.

A most interesting account of these galls was written by Semper in 1881 (p. 216).

I have described and figured (1897, p. 81) similar cages, with the crab *in situ*, on a branch of a *Millepora alcicornis* in the Liverpool Museum. Small spherical galls formed by Copepoda are also occasionally found on branches of the Stylasterina.

Tubular cavities similar to those of *Solenocaulon tortuosum* are frequently found on stony corals which are formed, not by Crustacea, but by the activities of Annelid worms. Even in the Pennatulacea a case is known of a Polychæte worm living in a tubular cavity on one side of the rachis of *Pennatula fimbriata* (see Hickson, 1916, p. 185).

The theory that all these gall-like structures are caused by the epizoic Crustacea or worms, and are in that sense pathological, is supported by the fact that in many cases, *e. g.* Seriatopora, Pocillopora, *Pennatula fimbriata*, specimens which undoubtedly belong to the same species may or may not bear the galls and bear them in different numbers or in varying positions on the corallum.

The alternative hypothesis that they are " inherent " characters of the hosts makes it impossible to find any reasonable explanation of their origin or utility.

The question whether *Solenocaulon ramosum* is or is not a good species should not be determined solely on the presence of the belts. Other considerations must also be taken into account. It is true that with these deep-sea Cœlenterata several tests of the validity of species are wanting which are available in the case of terrestrial animals, such as development and breeding. The principal guide, which is not really a test, that we can use until the development is known is discontinuity. That is to say, if a new specimen shows no connecting links with previously described species it may be regarded temporarily as a new species. If and when such connecting links are discovered it must be merged with the older species.

If *Solenocaulon ramosum* is not a valid species, to which of the older ones should it be referred ?

On this point my critics are not in agreement. Thomson and Simpson considered it to be an *S. tortuosum* and Stiasny (1937, p. 51) an *S. sterroclonium*.

But in the extraordinary regularity and size of the belts of specimens from the Maldives and the east coast of Africa, in the prominence of the verrucæ due to the larger

and more numerous spicules of the calyx and in some other minor characters there seems to be no continuity with the other species.

This may be the result of a selective adaptation for the reception of a particular kind of Crustacean which has become hereditary and therefore *S. ramosum* has acquired specific distinction, but until intermediate forms and younger stages are discovered this conception can neither be proved nor disproved.

It does not seem to me to matter very much whether it is catalogued as a species, an incipient species, an uncertain species or only a variety so long as the name is retained for future reference.

Family Melitodidæ.

Melitodes variabilis Hickson (1903, p. 809).

There are a few fragments of this species from Station 111, 73–165 metres in the Pemba Channel. They agree in every respect with some of the colour varieties from which the type specimens were described.

The nodes of the axis are dark red and the internodes vary from pale yellow to pale pink in different fragments. In one small fragment the nodes are yellow and the internodes pale pink.

The spicules are similar to those of the types in size and shape.

The principal interest of these fragments is that they prove the existence of this species in moderately deep water off the east coast of Africa.

The numerous examples of this species collected by Prof. J. Stanley Gardiner in the Maldive Archipelago were all littoral in habit, but Thomson and Mackinnon (1909, p. 198) described the species from Providence Island in 91 metres of water and Thomson and Simpson (1909, p. 169) from the Andamans in 82–493 metres and from the Gulf of Martaban in 121 metres.

The specimens in this collection came from a depth of 73–165 metres.

It seems certain from these facts that the species may be found at depths of over 100 metres without any modification in colour, variation or structure.

A similar case of extreme colour variation was found in *Chironepthya variabilis* from 37–40 metres of water in the Maldive Archipelago (Hickson, 1900*b*, p. 488). It is true that most of the deep-sea Alcyonaria are colourless and that very many of the shallow-water forms bear spicules of various colours; but several species, such as *Pennatula murrayi* from 400 metres (Hickson, 1916, p. 189) and two species of *Corallium* (Hickson, 1907, p. 6) from over 1000 metres have coloured spicules as bright as any of the shallow-water or littoral Alcyonaria.

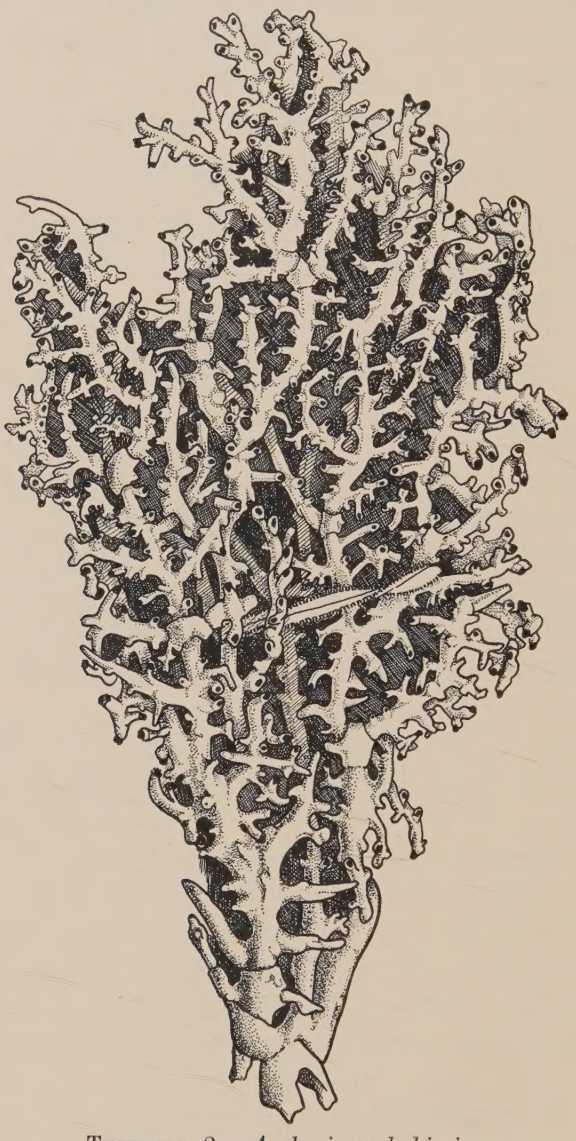
The development of the pigment in these spicules, therefore, does not depend upon the intensity of direct sunlight.

So far as is known at present the species is confined to the Indian Ocean. The specimens from the Malay Archipelago referred to this species by Nutting do not agree with *Melitodes variabilis* in the characters of the spicules (see Hickson, 1937*a*, p. 122).

Acabaria mabahissi n. sp. (Text-figs. 2, 3, 4.)

The following statements concerning the conditions at Station 24, off Cape Guardafui, where these very interesting specimens were collected, is of special importance in connection with some characters of the species.

Col. Sewell informs me that at this station (24, 73–220 metres) the bottom was found to be uneven and steep in places. During the trawl the vessel ran into deeper water that necessitated paying out an additional 150 fathoms of trawl wire. The nature of the bottom was coarse sand and shells, with apparently occasional patches of rock and encrusting barnacles. A strong surface current was setting to the west, with occasional "tide rips", and salinity observations in the neighbourhood indicated that this surface mass of water



TEXT-FIG. 2.—*Acabaria mabahissi*.

extended downwards to at least 200 metres depth. In this region the direction of the surface current changes with the onset of the north-east and south-west monsoons ; from November to May it flows westerly, with a rate of 16–20 sea-miles per day, rising in December to 26–30 miles per day, but from May or June to October it flows eastward, with a rate of some 31–40 miles a day.

The collection consisted of two complete specimens, with the base of attachment, three large specimens without the base of attachment, and several fragments. The five specimens were as follows :

No. 1 : Size, 100 mm. high by 60 mm. broad Without base of attachment. Colour : Stems pink, verrucæ red.

No. 2 : Size, 70 mm. high by 60 mm. broad. Complete with base of attachment. Colour : Stems pink, verrucæ pale orange red.

No. 3 : Size, 80 mm. high by 20 mm. broad. Two pieces of about the same size, without any base of attachment. Colour : White, with bright scarlet verrucæ.

No. 4 : Size, 90 mm. high by 50 mm. broad. Complete with base of attachment. Colour : A uniform muddy brown.

No. 5 : Size, 60 mm. high by 50 mm. broad. Colour : Stems pale yellow, verrucæ almost white.

Form of the colony.—This seems to be as variable as the colour. In all the specimens, except No. 2, the colony is compressed to form a complex flabellum. This consists of two or more fan-shaped main branches intimately woven together at the edges, but leaving wide tubular or more irregular spaces between them. Judging from the only two complete specimens (Nos. 2 and 3) the base of attachment is a thin membrane spreading over some calcareous rock, and from this base a broad saucer-shaped structure arises, from the edges of which one (in No. 2) or more than one (No. 3) expanded stems spring. In No. 2 the single stem curves and with its secondary branches forms an incomplete tube, but shows a tendency to become flabellate at the distal extremity. In No. 3 three principal stems spring from the base, and these give rise to two main closely adpressed fans.

Although the edges of the fans form a dense meshwork by overlapping, there are very few anastomoses of the branches.

It is quite impossible to describe adequately the complexity of the ramifications of these colonies ; but special attention may be called to the following points :

(1) The colonies of the four larger specimens are flabellate in form. This may be accounted for by the fact that they live in a locality where the main currents of water flow in opposite directions.

(2) The colonies are formed by two or more adpressed flabella, affording greater resistance to the currents of water, which are strong in this locality, than a single flabellum could do.

(3) The tubular spaces, the remarkably flattened branches and the saucer-shape base of the main stem are associated with the presence of epizoic Crustacea.

As the last of these statements may be disputed, the evidence in support of it may be given here. In the bottle containing the specimens a coral-haunting crab was found, which Mr. Ramadam identified as a species of the genus *Uroptychus* ; and in specimen No. 4 another crab lies imprisoned in the meshes of the flabellum. It is evidently too large to escape. As this crab remains in its original position it has not been identified, but is probably a *Uroptychus*.

All the branches, except a few terminal ones, are considerably flattened, being in many places three times as broad as they are thick.

On all these flattened branches the polyps are strictly bilateral, springing from the edges and never from the flat surfaces. On the rare terminal branches which are not flattened the polyps are more irregularly arranged.

Each polyp is represented by a very prominent verruca and a more or less contracted anthocodia at the top of it. They vary enormously in size, but an average of several measurements of the verrucæ gives the height as 0·3 mm. and the breadth at the base 0·6 mm.

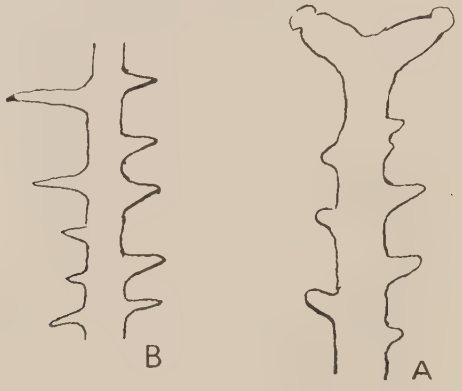
Most of the branches terminate in a characteristic way. At the tip there are two large divergent verrucæ and just below it a series of smaller verrucæ on both sides, becoming larger and larger as the distance from the tip increases (Text-fig. 3, A).

A very interesting and unique character of the species is that in the centre of each verruca there is a sharp spine-like projection of the hard axis (Text-fig. 3, B). Under no conditions of contraction can these verrucæ be withdrawn to the level of the general cœnenchym.

The axis is strongly flattened except at the extremities. The nodes are very short and almost everywhere of the same diameter as the internodes, and are therefore inconspicuous. The internodes are very hard and the surface smooth. I have not found any clearly marked fluting of the surface, such as is characteristic of the axis of most Acabarias.

The spicules of the nodes and internodes are the usual smooth rods about 0·1 mm. in length.

The colour of the internodes agrees with the colour of the cœnenchym which covers



TEXT-FIG. 3.—*Acabaria mabahissi*. A, The end of a terminal branch, × 8 diams.; B, a part of an internode of the axis showing the large spines which support the verucæ, × 4 diams.

them. The colour of the nodes of the white variety is very pale yellow and of the red varieties orange red.

The spicules.—The surface of the verrucæ bears a dense crowd of large spindles (Text-fig. 4) and clubs converging from the base towards the apex. No verruca has been seen on which any spicule is situated horizontally, at right angles to the axis of the polyp.

On the general cœnenchym the spicules are of the same types, but generally smaller. The spindles of the verruca have an average length of about 0·3 mm., but there are several seen in the preparations which are 0·3–0·45 mm. in length. The greatest diameter of the larger ones is about 0·05 mm.

Most of the tubercles are prominent, but simple, cones, but a few may be expanded to form a small leaf-like structure.

The clubs are of the same length as the spindles, but the tubercles at the thick end are more complex and crowded together than they are at the handle end. The tubercles in this region are not infrequently of the form of small thin leaves, and a few in which these leaves are larger and more numerous may be called " Stachelkeulen ".

The number of Stachelkeulen is very small, and in some of the specimens none were found. In the preparations in which they were found it was reckoned that there are not

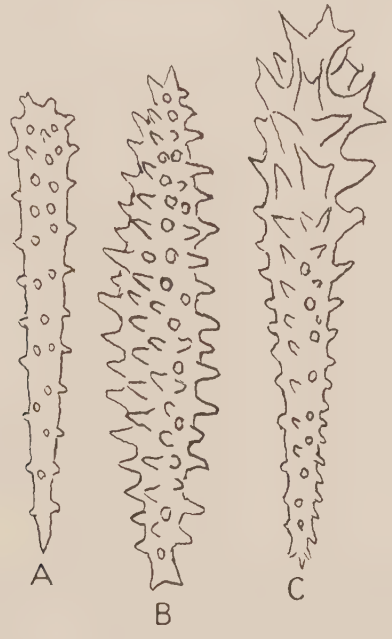
more than one in four hundred clubs. Towards the apex of the verrucæ there are some slender clubs with very small tubercles (Text-fig. 4, A). This is a very characteristic type of club.

The anthocodiæ are too much contracted and distorted to provide satisfactory preparations of the calices, but the crown consists of two or three rings of slender, bent spindles, 0·3 mm. in length, with very small tubercles. The spicules of the points are thicker and more heavily tuberculated.

No gonads were observed in any of the specimens. They were collected on October 9th, 1933.

Acabaria valdiviæ Kükenthal (1919, p. 180) from 318 metres off the Cape of Good Hope has some characters in common with *A. mabahissi*.

The polyps are bilateral in position and the verrucæ very prominent. The spicules



TEXT-FIG. 4.—*Acabaria mabahissi*.—A, A slender club at the apex of the verrucæ; B, a spindle; and C, a club of the Stachykeule type on the wall of the verrucæ. × 200 diams.

shown in Kükenthal's figures are very similar in type to those of *A. mabahissi*, but are evidently much smaller. In these characters the new species might be regarded as a variety of Kükenthal's species, and the flattened branches of the former might be regarded as one of the results of infection by epizoic crabs and not as a specific distinction from the Cape species, which has cylindrical branches and may be free from this influence. The colour difference is also one of no importance. But the arrangement of the spicules on the verrucæ and on the crown of the calyx is not a character that would be influenced by crabs or any other environmental condition, and in this respect the two species seem to be sufficiently distinct.

Kükenthal does not describe the spines from the axis which extend into the verrucæ in *A. valdiviæ*. In this respect, therefore, *A. mabahissi* seems to be unique, because it is difficult to believe that Kükenthal would not have recognized their importance if these processes were present in his species.

Acabaria erythræa Ehrenberg.

A full description of a large collection of specimens attributed to this species was published in a previous paper (Hickson, 1937*a*, p. 166). They were collected by the Murray Expedition at Station 45 off the south coast of Arabia in 38 metres of water.

Since that paper was published four small tubes containing one small specimen and some fragments from the same locality have been found. All of them show the same spicule characters as the larger specimens, and there is no special point of interest about them except that the small fan-shaped specimen, which is complete and only 30 mm. in height, would be very difficult to distinguish from *Acabaria pulchra* by external characters alone.

Sub-order HOLAXONIA.

Family Isididæ.

Genus *Isis* Linnæus.

There are some very small fragments of a colony from Station 54, 1046 metres, off the coast of Muscat.

The branches are very slender and bear widely-scattered hemispherical verrucæ, which are not bilaterally arranged.

The branches spring from the internodes.

The nodes of the axis are constricted and brown in colour ; the internodes are longitudinally grooved and pure white in colour.

The spicules are tri- and quadriradiate forms and a few small spindles. Only a few of these spicules exceed 0·05 mm. in greatest length or diameter. All the spicules are pale pink in colour.

As the larger of the two fragments is only 25 mm. in height by about 10 mm. in breadth it is impossible to identify them.

The extremely slender terminal branches, 0·1 mm. in diameter, with a very thin covering of cœnenchym, are very different from the thick, fleshy branches of *Isis hippuris*.

Moreover, the well-known species of this genus are shallow-water or littoral in habit. No specimens have been recorded hitherto from such deep water as 1046 metres. There is very good reason to believe, therefore, that these fragments belong to a species which is at present unknown to science.

Acanella africana Kükenthal (1919, p. 580).

Specimens or fragments of this species were obtained from Stations 50, 108, 109, 119, 122, 124 and 159 at depths of 640–1939 metres.

Two specimens came from a depth of 1536–1939 metres off the south coast of Arabia, some large fragments from 1280 metres off the Maldive Archipelago and all the rest from the Pemba Channel.

The specimens collected by the " Valdivia " Expedition came from numerous stations off the east coast of Africa at depths of 417–1644 metres.

The most perfect specimens are those from Pemba Channel (Station 108, 786 metres) and from the south coast of Arabia (Station 50, 1536–1939 metres). These are 240 mm.

and 200 mm. respectively in height, and both retain a part of the base of attachment, which consists of a variable number of long calcareous bands 3–8 mm. in breadth.

The greatest diameter of a main stem close to the base is 4 mm. The internodes between the base and the first whorl of branches are three or four in number and comparatively short, being only 3–8 mm. in length. Above the first branches they are usually much longer, many of them being 20–25 mm. in length.

The number of branches in a whorl is very variable, the average being about 5, but the minimum is 2 and the maximum I have observed is 6.

It is not necessary to give further details of the structure of this interesting species, because it was well described and illustrated by Kükenthal (1919, p. 580). But it was important to determine whether the specimens from the south coast of Arabia and from the Maldives were the same species as those from the east coast of Africa, and, as a result of the examination of a number of preparations of specimens from all three localities I came to the conclusion that they are identical.

This conclusion led to the consideration that the species is probably identical with the *Acanella robusta* of Thomson and Henderson (1906, p. 33) from deep water off the Andaman Islands ; but I have not been able to examine the type of this species.

I have compared my specimens with two complete colonies of a species called *Acanella normani* (Studer) from Martha's Vineyard, off the Atlantic coast of the U.S. of America. According to Kükenthal this species is identical with *A. arbuscula* of Johnson, which seems to be the prevalent species of this genus in deep water in the eastern side of the Atlantic Ocean.

From these observations and from a study of the literature of the genus I have come to the conclusion that *A. africana* and *A. robusta* of the Indian Ocean are distinct from the Atlantic species. However, it is quite possible that, when the variability of the species is better known, it may be proved that there is only one widely distributed but variable species. *Acanella* is a typical deep-sea genus and, like so many others, is not divisible into a number of clearly defined species. In this case, as in so many others, the creation of new species on the characters of a single specimen should be strongly deprecated.

Family Gorgoniidæ.

This family is not well represented in the Indian Ocean, many of the genera which are very abundant and rich in species on the east and western shores of tropical America being entirely absent.

Several species from East African shores which were previously referred to the genus *Gorgonia* must now be transferred to other genera For example, *Gorgonia flammea* (E. & S.), *G. crista* (Möbius) and *G. pinnata* (L.) are now included in the genus *Lophogorgia*. *G. albicans* (Hickson) probably belongs to the genus *Eunicella*. The interesting viviparous species *G. capensis* (Hickson) is better placed in the genus *Leptogorgia*.

There are no known species of *Gorgonia*, as that genus is defined in modern classifications (see Hickson, 1930, p. 248), in any part of the Indian Ocean.

The two genera *Lophogorgia* and *Leptogorgia*, which seem to be common on the western coasts of S. Africa, have crept round the Cape to become established on the east coast, but have not spread further into the Indian Ocean itself.

Two species of Gorgoniidæ from S. Africa which were originally referred to the genus *Eugorgia* (*E. gilchristi* and *E. lineata*) do not agree with the description of that genus given by Bielschowsky (1929, p. 170). All the other species are inhabitants of the seas off the western shores of America from S. California to Peru.

An examination of my original preparations of *E. gilchristi* and of J. S. Thomson's excellent account of both species (1916, p. 38) proves that they should be removed from the genus *Eugorgia* and be constituted the species of a new genus, or referred to the genus *Leptogorgia*. Neither of them are related to the genus *Stenogorgia* as Bielschowsky suggests (p. 185).

The genus *Stenogorgia* has a much wider range in the Indian Ocean than any of the other Gorgoniidæ, extending from S. Africa to the Nicobar Archipelago.

Genus *Stenogorgia* Verrill (1883, p. 29).

The genus *Stenogorgia* is usually included in the family Gorgoniidæ because its axis is black, horny and devoid of any calcareous deposits, but it differs from other genera of the family in its large polyps protected by prominent conical verrucæ and its large or very large spindle-shaped spicules with scattered simple tubercles.

The large fleshy branches of some specimens give them a superficial resemblance to species belonging to other families. Even Kükenthal was mistaken in the first draft of his great " Valdivia " monograph (1919), when he gave the name *Ellisella africana* to his new species of *Stenogorgia*, a name which persists, as a misprint, in his pl. xxxiii.

It seems probable that when this genus is further investigated the differences between it and other members of the family will be emphasized.

The type species *S. costa* was dredged in 617 metres off Cape Fear on the east coast of N. America and was well described by Verrill (1883, p. 30), and apart from those from the Indian Ocean mentioned above, other species which have been referred to the genus are *S. miniata* from the Antilles, *S. rosea* from the coasts of Sweden and Norway, *S. africana* from the mouth of the Congo, *S. studeri* and *S. miniata* from the Malay Archipelago.

The genus, therefore, seems to have a very wide geographical distribution in deep or very deep water.

I have great pleasure in naming the new species described below after Lt.-Col. Sewell, the leader of the Murray Expedition.

Stenogorgia sewelli n. sp. (Pl. I, figs. 3 and 4.)

There are three examples of this species in the collection, one from the coast of Hadramaut in 95 metres, one from the Pemba Channel in 90 metres, and a fragment from 37 metres off Cape Guardafui.

A very small specimen only 10 mm. in height, attached to a shell, which may belong to the same species, was found at the great depth of 1415 metres off the coast of Hadramaut.

There are certain differences in appearance between the first two specimens and, consequently, it is advisable to describe them separately.

Specimen A. (Pl. I, fig. 3.)

Station 43, 95 metres, off the coast of Hadramaut. The specimen is complete with a small but broken disc of attachment. It is 120 mm. in height and 130 mm. in breadth. It branches freely in one plane to form a flabellum. There is an unbranched main stem, 25 mm. in length by 3 mm. in diameter, from which the cœnenchym is detached and the black axis fully exposed. At the upper end of this stem branches are given off irregularly right and left, and these give rise to secondary and tertiary branchlets.

There are no anastomoses.

The general appearance of the colony resembles very closely that of a specimen of *St. miniata* from the Nicobar Archipelago shown in Kükenthal's pl. xlviii, fig. 91 (1919).

The diameter of the largest branch at its base is 3 mm. and of the terminal branches about 1 mm.

Most of the polyps are bilateral in position and there are several irregularly disposed on both sides of the flabellum.

The verrucæ are conical in shape, about 2 mm. in height and situated at distances of about 2 mm. apart.

In many cases the base of the anthocodia protrudes from the aperture of the verruca and is conspicuous by its glistening white colour contrasting with the red colour of the verruca.

At the end of the terminal branches there are two large divergent verrucæ and below them a very small one on each side, followed by others in an ascending series of sizes (Pl. I, fig. 3).

The spicules are all slender spindles provided with scattered, prominent, simple wart-like tubercles. There are no clubs or other varieties. The largest spindle in one of my preparations is 1·2 mm. in length and 0·15 mm. in diameter, and a rough average of several of the larger ones is 0·9 mm. The calyx can be clearly seen on many of the protruding anthocodiæ. It consists of a thick band of slender spindles forming the crown and eight points composed of similar spicules crowded together.

The colour of the cœnenchym and verrucæ is bright red, but the anthocodiæ are pure white.

The specimen was collected on October 28th. No gonads were observed in any of the polyps.

Specimen B. (Pl. I, fig. 4.)

Station 111, 73–165 metres, Pemba Channel.

This specimen differs from Specimen A in its thick branches, very large verrucæ and sparse ramification.

It is 210 mm. in height and bears only three branches arranged in the same plane. There is no base of attachment, and therefore it may represent only a portion of a very much larger colony.

The thickest part of what seems to be the main stem is 5·5 mm. in diameter between the verrucæ. The diameter of the main branches is 3·4 mm. at the base and 2·5 mm. at their extremities. The average height of the verrucæ is 4 mm., and from the apices of many of them the pure white anthocodiæ project for another 2 mm.

The spicules of the cœnenchym are similar to those of Variety A but considerably

larger, the average dimensions of about twenty large spicules in a preparation being 1·5 by 0·3 mm., and the largest over 2 mm. in length.

The colour is red and, as in Variety A, the anthocodiæ are pure white.

There were small female gonads in all the polyps examined. The largest ova were 0·2 mm. in diameter. The specimen was collected on January 14th.

The fragment from Station 27, off Cape Guardafui, in 37 metres, is a terminal branch of a specimen which may have been similar to Specimen A. It is about 80 mm. in length and bears five branchlets of various lengths. The spicules are similar to those of the other varieties, but the largest one in my preparation is only 0·7 mm. in length. The colour of the specimen is a brighter red than those from deeper water, and the protruding anthocodiæ are pale yellow. The geographical position of this specimen is about half-way between those from which the other two specimens came.

Notwithstanding the differences between these specimens in the degree of ramification and in the thickness of the branches, there can be no doubt that they belong to the same species. In the very large size of the spindles of the cœnenchym, the structure of the calyx and in the absence of clubs or other varieties of spicules, as well as in colour, they are identical.

It is true that the flabellum of Specimen A is very similar to that of an example of *Stenogorgia miniata* from the Nicobar Archipelago, as described and photographed by Kükenthal (1919, p. 643) ; but the spindles are not only much smaller (0·3 mm.) but quite different in tuberculation to those of *St. Sewelli*. Moreover, *St. miniata*, according to this account, bears clubs and short girdled rods, as well as spindles.

In *Stenogorgia ceylonensis*, from Trincomalee, as described by Thomson and Henderson (1905, p. 310), the spindles are much smaller (0·5 mm.) and much more densely tuberculated than in *St. sewelli*.

Stenogorgia africana, from 44 metres off the mouth of the Congo, was fully described and illustrated by Kükenthal (1919, p. 644).

In many respects it seems to be closely related to *St. sewelli*, but all the many specimens he examined were unbranched. The only spicules of the cœnenchym that are mentioned are spindles which attain to a size of 0·45 mm. in length.

The height of the verrucæ was only 1 mm., about one-quarter of the size of the verrucæ of Specimen A of *St. sewelli*, and no part of the anthocodiæ protrude from the apertures. These characters may be due, to some extent, to the greater degree of contraction in the " Valdivia " specimens.

Family Muriceidæ.

Genus *Bebryce* Philippi (1842, p. 35).

The first description of this genus was by Philippi in 1842, and the first drawings of the spicules of the genus were by Kölliker (1865, pl. viii, figs. 1–3). The type-specimen came from deep water off Naples.

It is upon the characters of the spicules that the identification of the species must very largely depend ; and therefore I have made a very careful examination of these structures in some specimens from the Naples type collection, very kindly sent to me by Dr. R. Dohrn.

In every general preparation spicules of various kinds may be seen, but the most

characteristic forms are those which are situated at the surface of the cœnenchym and verrucæ. The others will be referred to later.

There seem to be two kinds of these surface spicules (Text-fig. 5), some in the form of an ancient chalice or wine cup and others like a starfish in outline. The former may be only younger stages in the development of the latter. The chalice forms (*cf.* Kölliker's fig. 2 and Text-fig. 5, A of this memoir) consist of an upper expanded part representing the bowl of the cup, a short, smooth stem and an expanded base. The edge of the cup bears a variable number of short processes which, in some cases, are ornamented with tubercles. The base also bears a few tuberculated processes. These chalices are about 0·1 mm. in height. The starfish or stellate forms (Text-fig. 5, B) bear 5–8 tuberculated arms and are about 0·2 mm. in expanse from the tip of one arm to that of another on the opposite side of the star.

At the centre of the star a prominent knob is frequently seen, not unlike the boss of a shield, but when this is carefully focussed it is found to consist of a short stem and swollen, tubercular extremity. As these spicules are usually arranged in a preparation

TEXT-FIG. 5.—*Bebryce mollis*. A, A "chalice" spicule; B, a "star" spicule. × 200 diams. From a specimen in the type collection at Naples.

with the star-like expansions flat on the glass the true form of the spicule is difficult to see. It is that of a chalice with a widely-expanded cup and a small stem and base. It is better observed in a small heap of dry spicules in which some of them may be seen sideways.

There are many variations in the size, degree of tuberculation, and in the number of processes of the cup and of the base in both these types, but strictly intermediate forms are rare.

The other spicules of the ordinary preparations, the thin, bent spindles of the calyx and the spindles, crosses, twins and quadruplets of the inner layers of cœnenchym, are often seen in other genera of Gorgonacea and are of minor importance for systematic purposes.

The other characters that have been described for the Mediterranean *Bebryce* may be found in the writings of previous authors, but some comment is necessary, based on investigations of the specimens of *B. mollis* in the Murray collection.

In the eighteen specimens from Station 157 the maximum height is about 100 mm., that is to say no really large ones were found; they were all either unbranched or slightly branched, the branches being in one plane without any anastomoses, and the colour dark brown. In these respects they agree with the specimens sent to me from Naples. As regards the thickness of the branches, the size and arrangement of the verrucæ on the

branches there is so much variation that these characters are useless for the purpose of a definition of the genus or species.

Thomson and Simpson recognized four Indian Ocean species of *Bebryce* in addition to *B. mollis*. These are *B. hicksoni*, *B. indica*, *B. tenuis* and *B. acanthoides*. The descriptions of the first three of these species prove that they are certainly not identical with *B. mollis*, but the spicule characters are so different from those of the genotype that there seems no good reason to refer them to the genus *Bebryce* at all.

I have been able to examine some examples of the species called *B. acanthoides* by Thomson and Russell (1909, p. 151). They were dredged in 91–142 metres off Providence Island, north of Madagascar. They bear no spicules similar to the chalices and stars of *Bebryce* and the surface of the cœnenchym is protected by thick, warty spindles, 0·2 mm. by 0·1 mm. in size, and numerous spheres 0·17 mm. in diameter. This species, therefore, should not be referred to the genus *Bebryce*.

I have re-examined my preparations of the *Bebryce* sp. ? from South Nilandu (1903, p. 813) and can now definitely assign it to *B. mollis*.

Kükenthal (1919, p. 841) has removed all the species formerly referred to the genus *Bebryce*, except *B. mollis*, to form a new genus, *Pseudobebryce*, and has therefore restricted the distribution of *Bebryce* to the Mediterranean Sea, the Azores and "Seinesbank". Thomson and Dean (1931, p. 205) say that they cannot for a moment accept the separation of *Pseudobebryce* from *Bebryce*, and Aurivillius also (1931, p. 189) did not accept Kükenthal's new genus. Kükenthal was certainly in error in referring all the Indian and Pacific Ocean species to *Pseudobebryce* because, when specimens and spicule preparations of *Bebryce mollis* from Naples and the specimens from Station 157 are compared, side by side, there can be no doubt of their generic identity. Moreover, the fragment I described as *Bebryce* sp. ? (1903, p. 813) from the Maldives undoubtedly belongs to the same species.

Studer (1889, p. 10) gave a very good description of a specimen from 89 metres in the Arafura Sea which he called *Bebryce philippi*. It was larger than any of the specimens from the Maldives, but, as Thomson and Simpson maintain, it is identical with *B. mollis*.

It may be noted here that Miss Deichmann (1936, p. 125) has recently described three new species from the West Indies which are correctly referred to the genus *Bebryce*.

The question whether the four species from the Indian Ocean described by Sir Arthur Thomson and his partners (*vide supra*) are correctly referred to *Bebryce*, depends upon the definition of that genus which is accepted.

If it is agreed that the presence at the surface of the ectoderm of the chalices and stars are the essential characters of the genus, they certainly do not.

If, on the other hand, this view is not accepted, then the genus is very difficult to define.

In my view Kükenthal's definition of the genus (1924, p. 208) in so far as it insists on this character of the spicules, is scientifically most convenient and should be accepted.

To include all Thomson's species in a new genus "*Pseudobebryce*", as Kükenthal does, is not satisfactory.

A re-examination of the type-specimens of these species is necessary before a definite solution can be found for the problem of their correct position in our system of classification, but most probably they should not be included under one common generic name.

Bebryce mollis Philippi.

Specimens belonging to this species were obtained from three stations, namely: Station 157, 229 metres, Maldives; Station 24, 73–220 metres, off Cape Guardafui; and Station 10, 55 metres, in the Red Sea.

In the collection from the Maldives there are eighteen specimens complete with the base of attachment, and several fragments.

They are of various sizes up to a maximum height of 100 mm. and a width of 60 mm. when the branches are spread out.

Several specimens are quite unbranched, but others show a few simple branches arranged in one plane. There are no anastomoses of the branches.

They are attached at the base either to solitary corals (*e.g. Paracyathus conceptus*) or to stones. The collection is of great interest because it shows the great variation of specimens living in the same locality as regards certain characters, such as their ramification and the size and distribution of the verrucæ, which are sometimes used for making specific distinctions.

Some of the specimens have thick (5 mm. in diameter) branches with large verrucæ crowded together on all sides, others have slender branches (2 mm. in diameter) with sparsely distributed and relatively small verrucæ, which may be either bilaterally arranged or irregularly scattered.

The characteristic spicules, the chalices and stars are almost exactly the same as those of the Naples specimens.

One specimen examined contained small ova (0·15 mm. in diameter). It was collected on April 6th.

The two small fragments from Cape Guardafui have exactly the same spicules, and undoubtedly belong to the same species as the specimens from the Maldives.

There is a small specimen from a depth of 55 metres at the southern end of the Red Sea which differs in some respects from the others, and might be regarded as a new variety (var. *ethiopeæ*). It is 60 mm. in height and the main stem gives rise to two secondary branches from which spring numerous terminal branchlets all in one plane. The branches are slender and the verrucæ comparatively small and most arranged bilaterally.

There are no anastomoses.

The colony is apparently complete as there is a small disc of attachment torn from some calcareous substance.

The spicules, however, are not exactly the same as those of the type species. There are chalices and stars, but both forms are decidedly smaller than in the types, the former having an average height of about 0·08 mm. and the latter a diameter of 0·15 mm. The stars bear much shorter and more numerous (14–15) tubercular marginal processes, and together form a close-set armour-plating at the surface of the cœnenchym.

This interesting specimen was found in shallower water than any of the others and, in my opinion, the difference observed in these spicules may be only adaptations due to the shallower water and, perhaps, other environmental conditions in the Red Sea. Other specimens from that region may prove that it is a representative of a new species but for the present it is better to regard it as a variety of *B. mollis*.

Echinomuricea andamanensis Thomson and Simpson (1909, p. 203).

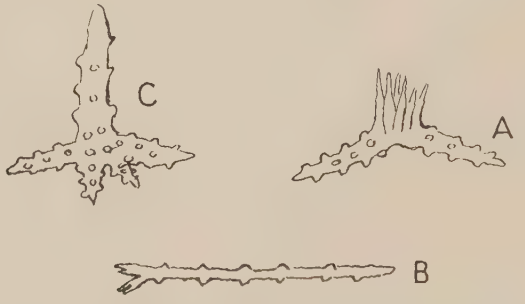
There are two complete specimens, measuring 100 mm. in height and 120 mm. in breadth and 60 mm. height by 50 mm. breadth, respectively, and three fragments of the flabella in the collection from Station 43, 95 metres, off the coast of Hadramaut.

The branching is irregular but entirely in one plane. In the larger complete specimen there are a few anastomoses, in the smaller one there are none. A few anastomoses occur on some of the fragments.

The thickest part of the main stem is only 2 mm. in diameter. The diameter of the terminal branches is about 0·6 mm.

The verrucæ are arranged all round the branches at distances of 0·5–1·0 mm. apart. They are almost cylindrical in form, 0·6 mm. high and 0·6 mm. broad.

The surface of the cœnenchym is covered with spicules from which protrude various sharp thorny processes. On the verrucæ, and particularly at their margins, these projecting processes are longer and more dagger-like. It seems to be a character of this



Text-fig. 6.—*Echinomuricea andamanensis*. A, A spicule from the surface of the cœnenchym; B, from the lower layers of the cœnenchym; and C, from the margin of the verrucæ. × 200 diams.

species that the spines of these marginal spicules are not so prominent as they are in other species of the genus.

The spicules at the surface of the cœnenchym are very variable in form (Text-fig. 6, A). They all show long spreading tuberculated roots varying from two to four in number and, springing from the centre of this group of roots, there is a tuft of small sharp thorns about 0·05 mm. in length, which protrude through the surface of the cœnenchym. The roots are very variable in length, but their total span is about 0·2 mm. It is noteworthy that in all my preparations I have not found one with a thin plate-like expansion in place of the group of thorns, such as we find in abundance in Acamptogorgia.

Beneath the surface and lying close to the axis there are several very irregular, straight or bent spindles up to 0·4 mm. in length and 0·05 mm. in breadth (Text-fig. 6, B).

On the verrucæ and particularly at their margins the groups of thorns are replaced by a single dagger-like spine, which varies in length from 0·1–0·2 mm. in length (Text-fig. 4, C). These spines are not quite smooth but show a few rounded tubercles near their bases (Text-fig. 6, C).

The roots of these spicules are similar to those of the spicules of the cœnenchym.

The calyx (operculum) can be clearly seen protruding from the verruca of several polyps. It consists of a crown of one row of thin bent spindles and eight points, each bearing a pair of almost parallel slender spindles slightly bent at their proximal ends.

All the spicules are colourless.

The colour of the colony is pale brown.

There is great difficulty in determining the species of this genus. No less than ten species have been described from the Indian Ocean alone and in addition to these, three species, *A. gracilis* and *A. rubra* Thomson (1905, pp. 177, 178) and *A. horrida* Hickson (1903, p. 814), previously referred to the genus *Acamptogorgia*, are most probably species of *Echinomuricea*.

The genera *Echinomuricea* and *Acamptogorgia** are closely related in some respects; but a reference to the type specimens in the "Challenger" collection shows that they may be fairly regarded as generically distinct.

I have examined spicule preparations of the types of *Acamptogorgia arbuscula* and *A. alternans* and in both these species the thin plate-like expansions on the upper side of the cœnenchym spicules are clearly seen. Some good drawings of these spicules were published by Wright and Studer (1889, figs. 4 and 5). I can find no such plate-like expansions in any species of *Echinomuricea* that I have examined.

Another distinction between the two genera is that in *Echinomuricea* the margin of the verruca bears spicules with long dagger-like projections which usually provide a ring of prominent protective spines for the retracted anthocodiæ.

Most of the Indian Ocean species of this genus have been described from single specimens. We have consequently no information as to the degree of variation that may be present, and until a large number of specimens from a single locality have been examined the reference of any specimen to a previously described species must be regarded as only provisional.

With some hesitation, therefore, I have referred the specimens in the John Murray Expedition collection to Thomson and Simpson's species *E. andamanensis*. They agree with that species in colour, in the small number of the anastomoses, in the short spines of the spicules on the margin of the verrucæ, and in the presence of a few tubercles on these spines.

It is possible that they are only young forms of *E. reticulata* of the same authors (*l. c.*, p. 206), which is much larger, bears many more anastomoses, and has smooth spines.

Both these species came from the Andaman Islands, but in neither case is the depth of the locality mentioned.

Another species which has a wide distribution, occurring in the Torres Straits, Malay Archipelago, Singapore and Ceylon, of which I have examined several specimens, is clearly a distinct species. This species is *Echinomuricea indo-malaccensis* Ridley.

Genus *Menacella* Gray (1870, p. 406).

There is no satisfactory modern definition of this genus. In Gray's original statement the most important characters are that the bark is "very thin and formed of numerous very slender fusiform spicules in bundles placed in different directions. Polype cells short, cylindrical covered with spicules like the bark, with a smooth eight-rayed lid."

Ridley (1882, p. 191) re-examined Gray's type specimen and described the spicules

* Kükenthal (1924, p. 192) changed the name *Acamptogorgia* to *Perisceles*, but, as pointed out by Wright and Studer (1889, p. lv), the generic name *Perisceles* was already occupied for a genus of Coleoptera. *Acamptogorgia* must therefore stand.

as " simple tuberculate fusiform spindles with strongly micro-tuberculate or exfoliating tubercles ". And he adds that " the largest measure 0·5 mm. by 0·10 mm."

Kükenthal (1924, p. 147) says that the tubercles of the spindles are " fein gezacht oder blattartig verbreitert ", and that the " operculum " is formed by three spindles arranged in a triangle with a base composed of a ring of thin spindles.

I can find no reference in any of Kükenthal's numerous papers which show that he made original observations on the genus and, therefore, it seems probable that his description of the " operculum " was derived from the description by Nutting (1910*a*, p. 47) of some specimens from Bali which he identified as *Menacella reticularis*. Unfortunately, Nutting's account of this species was not illustrated by any figures, and the size of the spicules was not mentioned. There may be some hesitation in accepting Nutting's identification of the Bali specimens as correct ; but even if it is, there is no reason for accepting his description of the operculum as a character of the genus.

Kükenthal's account of the tubercles of some of the spicules as being leaf-like (blattartig) seems to be due to his interpretation of Ridley's very vague expression " exfoliating ". I have examined a preparation of the spicules of Gray's type of *Menacella reticularis* and could find none of them with leaf-like tubercles.

The characteristic features of the genus are : (1) the eight triangular flaps of the upper end of the verrucæ, forming the operculum of some authors, but not to be confounded with the calyx of other genera ; (2) the spindle-shaped and oval spicules with densely crowded tubercles which, without being arranged in any definite order, form a protective crust for the cœnenchym and verrucæ.

Menacella reticularis Gray (1870, p. 406).

There is one example of this species in the collection from Station 151, off the Maldive Archipelago, at a depth of 101 metres.

The base of attachment is missing, but the specimen is otherwise complete. It is fan-shaped, but the branches are not quite in one plane. It is 100 mm. in height and 120 mm. in breadth. The thickest part of the main stem is 4 mm. in diameter. It bends in a curve to one side and all the secondary branches spring from its convexity. This is an unusual method of branching in the flabelliform Gorgonacea and seems to be a characteristic feature of the species.

There are no anastomoses.

The polyps are mainly bilateral in position and, in the partially retracted condition, are approximately 0·6 mm. in length and the same in diameter.

The colour is dark brown.

The spicules are in the form of spindles and clubs bearing numerous densely crowded tubercles which are not arranged in definite whorls. These tubercles are usually short cylindrical processes about 0·005 mm. in height, expanding a little at the distal end, to end in a crown of very minute knobs. It is not quite clear what Ridley meant by the expression " exfoliating " as applied to these tubercles ; but there are none in my preparations which show leaf-like expansions.

The size of the largest of these spicules is 0·2 mm. by 0·04 mm. In the examination of several hundreds of spicules spread out on a slide I found a few that are slightly larger

than this and, of course, several that are much smaller, but the figures given above represent the size of most of the full-grown spicules. The verrucæ are armed with densely crowded spicules of approximately the same size as those of the general cœnenchym, and there is no definite arrangement of these spicules in rows or in any other pattern.

At the distal end of the verrucæ there are eight triangular lobes, forming the "lid" of Gray and the "operculum" of other authors.

In the description of the type of this species no locality is given, but on the slide of the spicule preparation the words "British Columbia" are written.

This locality, however, cannot be trusted. I have examined collections of Alcyonaria from various localities off the west coast of North America, including British Columbia, and have seen no examples of species of this genus.

According to Nutting (1910, p. 46) the species occurs in the Bali Sea, and Thomson and Dean (1931, p. 198) record fragments of it from a locality off Misol Island, also in the Malay Archipelago.

The specimen described above differs from the type in the size of the spicules, which are, according to Ridley's statement, 0·5 mm. in length, and 0·4 mm. according to my own measurement of the spicules of the type specimen. In the Maldive specimen they are only 0·2 mm. in length.

Nutting (1910*a*, p. 46) says the colony of his specimen "is unilateral, most of the branches being on one side of the main stem", as it is in the Maldive specimen.

No statement is made by Gray or Ridley to show that the type specimen had the same peculiarity of colony formation, and it is, therefore, impossible to say that this is a good specific character.

It is unfortunate that neither Nutting nor Thomson and Dean mention the size of the spicules of the Malayan specimens, nor gave a figure of them, nor do they record the presence of clubs in their preparations.

In conclusion, it seems to me better to retain the name *M. reticularis* for the Murray Expedition specimen rather than invent a new name on the characters of a single specimen.

Menacella sladeni Thomson and Russell (1910, p. 150). (Pl. I, fig. 5.)

Station 157, 229 metres, Maldives.

There are two specimens from this locality which present a problem of unusual interest and difficulty, but I have decided to refer them to the species *Menacella sladeni*.

One of the specimens is 150 mm. in height and about 90 mm. in width. It was attached at its base to a *Paracyathus conceptus* (Gardiner and Waugh, 1938, p. 184). The other was only a branch of another specimen and is 100 mm. in length.

The ramification is sparse and the branches are arranged definitely in one plane without any anastomoses (Pl. I, fig. 5).

The diameter of the main stem of the larger specimen is 4 mm. and of the terminal branches 3 mm. The larger branches are distinctly flattened and the polyps mainly bilateral in position, but at their terminal extremities they become round in section and the polyps are more irregularly scattered.

The larger verrucæ are crater-like cones about 0·8 mm. in height, 1·5 mm. in diameter at the base and 0·9 mm. in diameter at the top.

In the centre there is a deep pit in which are the shrivelled remains of the anthocodiæ. It is probable that the specimens were either dead or moribund when captured.

The verrucæ terminate above in eight triangular flaps bent over but not covering the crater-like aperture. The spicules at the surface of these flaps do not differ from those of the general surface of the cœnenchym, and are not definitely arranged in lines. The cœnenchym is moderately thick, *i. e.* in a branch 3 mm. in diameter the axis is 2 mm. and the cœnenchym about 0·5 mm. thick. It is not layered, but there are 6–8 spicules irregularly arranged in a line drawn vertically from the surface to the axis.

The general surface of the cœnenchym and verrucæ is granular in appearance due to the presence of numerous small spicules, which are not arranged in definite rows nor form any other pattern.

The spicules (Text-fig. 7) at the surface of the cœnenchym vary in outline from thick spindles 0·23 mm. by 0·05 mm. in size to stout oval forms 0·23 mm. by 0·07 mm. in size, with numerous intermediates.

In the deep layers of the cœnenchym near the base of the main stem the spicules are slightly larger than this. The difference is hardly noticeable, but as a result of numerous

Text-fig. 7.—*Menacella sladeni.* Spicules of the general cœnenchym. × 200 diams.

measurements it may be said that the length of the largest spindles at the surface rarely exceeds 0·26 mm., whereas in the deep layers at the base of the colony the length is often 0·3 mm.

In all the spicules the tubercles are short, stout knobs, sometimes flattened at the top and very densely crowded together. There are no spicules with exfoliating tubercles nor any in which the tubercles are arranged in whorls.

The large specimen, collected on April 6th, bore numerous gonads up to 0·14 mm. in diameter.

The type specimen of *Menacella sladeni* is in the British Museum. It is 30 mm. in height and may be only a small fragment of a much larger colony. It has only a few branches, and these are about 2 mm. in diameter.

It was dredged in 46 metres off Providence Island, between Madagascar and the Seychelles.

As the type specimen, like the one described above, differs so remarkably in its sparse ramification and its thick branches from *M. reticularis*, some doubt has been felt as to whether it was correctly referred to the genus *Menacella*.

An examination of this specimen shows, however, that, as in *M. reticularis*, the verrucæ terminate above in eight triangular processes armed with spicules similar to those on the

verrucæ and the cœnenchym. Moreover, as the specimen is dry, the size, shape and tuberculation of the spicules can be clearly seen *in situ* and are found to be almost exactly similar in these respects to the spicules of the type of *M. reticularis*.

There is one important point in which I have been unable to confirm the original description of the species by Thomson and Russell. They say that " on the walls of the verrucæ there is a definite arrangement in eight double rows of small spicules *en chevron*".

I have carefully examined every verruca on the type specimen and have not seen such a definite arrangement of the spicules on any of them. In every case the spicules on the verrucæ are of the same type as those on the cœnenchym and quite irregularly scattered.

It is this point that Kükenthal (1924, p. 147) seized upon when he said that *M. sladeni* does not belong to the genus *Menacella* : " weil die Kelchskleriten in acht konvergierenden Doppelreihen angeordnet sind."

Genus *Paracis* Kükenthal (1919, p. 837).

There is considerable confusion in the literature of the subject as to the characters which distinguish *Acis* from *Thesea*, and also as a result of the proposal to abandon the generic name *Acis* and substitute for it the names *Scleracis* for most of the West Indian species and *Paracis* for the Indian Ocean species. Miss Deichmann (1936) has recently examined the type specimens of *Acis* (*Scleracis*) *guadaloupensis* and a large number of specimens belonging to the same species from various localities in the West Indies and the coast of Florida. She has also examined the type specimen of *Thesea guadaloupensis* (D. and M).

Kükenthal (1924, p. 153) has, most unfortunately, referred Duchassaing and Michelotti's type species *Acis guadaloupensis* to the genus *Thesea*, so that according to his system this species disappears from the genus *Acis* altogether.

Two important conclusions can be drawn from the study of Miss Deichmann's paper. In the first place, that the cœnenchym of the type species of *Thesea* has two layers and that, therefore, the distinguishing character which, according to Kükenthal (1924, p. 140), separates *Thesea* from *Scleracis* and *Paracis* is unsound ; and secondly, that it is very doubtful if the West Indian species of *Acis* (*Scleracis*) are generically distinct from the Indian Ocean species (*Paracis*) (Deichmann, p. 108).

The character given by Kükenthal (1924, p. 140) to distinguish *Scleracis* from *Paracis*, namely, that in the former genus the polyps are situated laterally on the branches and in the latter that they are not, cannot, in the light of Deichmann's investigations, be accepted as sound.

The best plan now would be to return to a simpler classification, to restore the genus *Acis*, to abolish *Scleracis* and *Paracis*, and to regard *Acis* as a genus, which like *Leptogorgia* and *Iciligorgia*, has a distribution both in the West Indies and eastern oceans (see Hickson, 1938, p. 594). But, unfortunately, the name *Acis*, given to this Muriceid by Duchassaing and Michelotti in 1860 was preoccupied by Billberg for a Coleopteran in 1823 and therefore *Paracis* (Kükenthal, 1919, p. 837), having page preference over *Scleracis*, must be the name of the combined genera.

A satisfactory distinction between the genera *Paracis* and *Thesea* has still to be found. In Deichmann's key index (1936, p. 99) *Scleracis* is distinguished from *Thesea* by the spicules of the outer layer being " glass-like, transparent, as large spindles or plates " ;

whereas in *Thesea* these spicules are "not glass-like, nor transparent; as grains, plates or spindles". This does not seem to me a satisfactory definition for any genus, because the transparency of these white spicules is a very variable character. In *Paracis orientalis* and in the type of *Thesea guadaloupensis* there is no appreciable difference in the transparency of the spicules.

In the specimen of *Paracis orientalis* described below and in the type of the same species a very striking feature is the presence of long spines on the spicules at the margin of the verrucæ. No such spicules are found in my preparation of the spicules of *Thesea guadaloupensis*.

Are such spicules found in the West Indian species referred to the genus *Scleracis* ? No definite answer can be given to this question at present; but Riess (1929, p. 406) in her elaborate account of *Scleracis pumila* says: "Acht konvergierenden Doppelreihen von Spindeln bilden ausserdem am Kelchrand oft vorragende Spitzen." No such spicules, however, have been figured for the West Indian species.

Paracis (*Acis*) *orientalis* Ridley (1882, p. 126).

The only specimen of this genus in the collection was found at Station 24, 73–220 metres, off Cape Guardafui.

It is a small specimen, 40 mm. in height by 40 mm. in breadth. It is in the form of a perfect little fan, with few branches without anastomoses, and with a small disc of attachment.

The polyps are situated on all sides of the branches and are represented by verrucæ in various stages of contraction, the largest being about 1·3 mm. in height and 1 mm. in diameter.

The surface of the cœnenchym is armoured with numerous flattened scales of very variable size and shape, but all densely tuberculate with small compound tubercles. Most of these scales are spindle-shaped and reach an average length of about 1 mm. by about 0·5 mm. in greatest breadth, but there are various other shapes and sizes fitting into spaces between the spindles. There is no appreciable difference between the size of the tubercles of these spicules and that of the spicules of the type. Beneath this outer layer there is an inner layer of smaller spindles.

The verrucæ have a very ragged appearance, due to distortion in contraction.

They are armed for the greater part of their length by longitudinally-arranged spindles similar to but smaller than those of the cœnenchym, but at the upper margin there is a row of scales armed with one, two or three long projecting spines. These spicules are extraordinarily variable in form and in the number and size of the projecting spines (Text-fig. 8).

The calyx is, in most cases, completely hidden in the verrucæ, but where it can be seen it consists of a crown of rings of horizontal spindles and eight points, each bearing two bent spindles. The exact number of rings in the crown could not be determined as they were never fully exposed, but the number must be three or more.

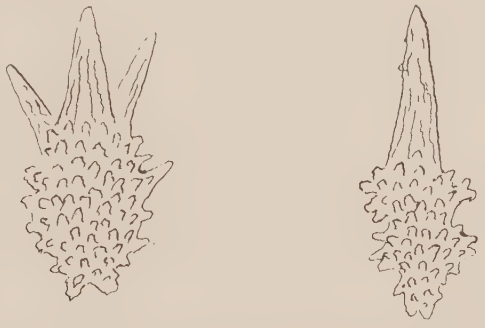
The colour of the colony is pale brown, but the spicules are all white.

The first species of *Acis* to be described from the Indian Ocean was *A. orientalis*. It was founded on three specimens from 80 fathoms (146 metres) of water off Mauritius, and was fully described and figured by Ridley. I have examined a branch of one of these

specimens and some preparations of its spicules and can find no difference of any specific importance between this type and the single specimen from Cape Guardafui.

Since Ridley's paper was published no less than nine new species have been described from the Indian Ocean by Thomson and Henderson (1905), Thomson and Simpson (1909), and Thomson and Russell (1910). Of these species *Paracis ceylonensis* seems to be widely distributed in this ocean and, as several specimens were examined, a considerable amount of variation in the manner of branching was recorded (Thomson and Simpson, p. 232). Most of the other species were based on the examination of one or two specimens only. Thomson and Russell (p. 157) give a key for the identification of the species of *Acis*, according to which the difference between *Acis ceylonensis* and *A. orientalis* is that in the former the spicules are " round and pebbly ", and in the latter they bear " large tubercles ".

This is a very unsatisfactory distinction bearing in mind the wide range in variation in the spicules of the type of *A. orientalis*. It seems probable, therefore, that *A. ceylonensis* is little more than a variety of the older species.



Text-fig. 8.—*Paracis orientalis*. Two examples of the spicules at the margin of the verrucæ. × 50 diams.

Genus *Versluysia* Nutting (1910*a*, p. 35).

Nutting did not give very clear reasons for separating this genus from *Muricella*. On consulting his key index of the genera of the Muriceidæ on his pages 9–10, *Versluysia* is found to be included among the genera in which the " spicules are nowhere arranged *en chevron* ". In *Muricella*, on the other hand, the spicules are arranged " *en chevron* on the calyx-walls and tentacle-bases ".

He took as his genotype the species called *Muricella ceylonensis* by Thomson and Henderson (1905, p. 302), but also included in the genus *Muricella ramosa* of the same authors, p. 301.

In a later and more carefully considered paper by Thomson and Simpson (1909, p. 249) *M. ceylonensis* was merged with *M. ramosa*, and the latter name has page-priority for the combined species. In the description of *M. ramosa*, as thus reconstituted, these authors state distinctly that there is an " operculum " consisting of about eight spindles arranged *en chevron*.

Nutting's key index character does not apply to *Versluysia ramosa*.

There are, however, some wide differences between most of the older species of *Muricella*, such as *Muricella nitida* amd *M. tenera*, and some of the species from the Indian Ocean, which I have not had the opportunity to investigate fully, and it is possible that the retention of the genus *Versluysia* may yet be justified.

There is, however, a close relationship between *Muricella*, *Versluysia*, *Anthogorgia* and *Calicogorgia*, and it might be a great advantage if some of these ill-defined generic names of these Muriceidæ could be suppressed.

Versluysia ramosa Thomson and Henderson (1905, p. 301).

Versluysia ramosa, Nutting (1910*a*, p. 37).
Muricella ramosa, Thomson and Simpson (1909, p. 249).

Thomson and Simpson merged *Muricella ramosa* and *M. ceylonensis* to form one species, and there are three specimens in the Murray collection which agree with the description given by these authors of that species.

A specimen from Station 35, near Aden, 441 metres.

A large complete specimen, 280 mm. in height and 200 mm. in expanse, is in the form of a perfect flabellum.

The disc of attachment is 15 mm. and the main stem is 5 mm. in diameter. There is no cœnenchym left on the stem and main branches and only patches left on the secondary branches ; and therefore the jet-black axis is fully exposed over a great part of the colony. Anastomoses are scarce.

A specimen from Station 45, off coast of Hadramaut, 38 metres.

An incomplete colony, 120 mm. in height by 120 mm. in expanse, attached to a mass of coral conglomerate. Parts of the terminal branches are broken off. The main stem, 4 mm. in diameter, is formed by the fusion of two stems which rise from two attachments hidden in the conglomerate. The cœnenchym is much better preserved than in the specimen from Station 35, and covers most of the branches. There are very few anastomoses.

A specimen from Station 27, off Cape Guardafui, 37 metres.

This is incomplete, the main stem and disc of attachment being lost. It consists of a network of branches about 120 mm. in expanse. The branches are more delicate and the anastomoses far more frequent than in either of the other two specimens. The cœnenchym is well preserved.

Associated with this specimen were large numbers of the polychæte worm *Syllis* (*Haplosyllis*) *spongicola* Grube.

The specimens agree with the description of the species given by Thomson and Simpson (1909, pp. 249 and 253) in possessing a very thin cœnenchym through which the black axis can be seen, the small verrucæ and their irregular distribution on the branches, the general flabellar mode of branching and the presence of anastomoses. These authors examined a large number of specimens, including those of the Wood-Mason collection, and came to the conclusion that in many respects the species is very variable. The only point of difference appears to be that the spicules of the cœnenchym are smaller in the Murray specimens than in the types. After searching through many hundreds of spicules from all three specimens, the largest spindle I could find was only 1·5 mm. and there were very few over 0·7 mm. in length. Thomson and Simpson found some spindles 2·5 mm. and others 4 mm. in length. As this is a very variable character it is probably not of much importance.

The verrucæ are ragged in appearance, but roughly dome-shaped and about 1 mm. in breadth by 0·5 mm. in height.

The calices which form the so-called " operculum " consist of a crown of 4 or 5 rings of horizontal spindles and eight points of 6 or 8 spindles arranged irregularly *en chevron*.

The species has a wide distribution in the Indian Ocean, having been found in the Andaman Sea, off the west coast of Ceylon and in the Persian Gulf, as well as at the three localities given in this paper. The depth in which it occurs is, frequently, 70–90 metres, but there is one record of 441 metres given above.

Family Gorgonellidæ.

Gorgonella granulata ? Esper (1794–1806).

There are two fragments in the collection which may be referred provisionally to this species. They were dredged at Station 45, off the coast of Hadramaut, in 38 metres of water.

They are 70 and 55 mm., respectively, in height, and both of them are bright red in colour. They branch in one plane and there are no anastomoses.

The thickest branch is 5 mm. and the terminals uniformly 4 mm. in diameter, the latter with blunt extremities.

The polyps are situated all round the branches and are represented at the surface by low mounds, about 1 mm. in diameter, with a stellate aperture.

Spicules.—Nearly all the spicules in a preparation are double clubs with two to four distinct whorls of prominent tubercles. The average length of the largest spicules is 0·1 mm. In some of them the whorls are not so well pronounced, the tubercles being more unevenly distributed.

There are also a few small spheres and other types of spicules.

The form of the double clubs is very similar to the figure of a spicule of *Gorgonella pseudo-antipathes* given by Kölliker (1865, pl. xviii, fig. 42).

The axis of these fragments has a smooth surface and it is heavily calcified.

These fragments have a very close resemblance to the terminal branches of the specimen shown in Esper's pl. iv of *Gorgonia granulata*. Kölliker (pl. xviii, fig. 43) gave two figures of the spicules of this species, one of them of a double-club which has a close resemblance to the smaller spicules of the specimen described above, the other of a spindle which is represented in my preparations by a very few examples. Thomson and Simpson (1909, p. 274) resuscitated the species for a yellowish brown specimen from the Andaman Islands and a much battered specimen from the Wood-Mason collection of unknown habitat.

The double clubs of the Andaman specimen, however, have only one whorl of tubercles, and it bears several types of spicules that do not occur in the Murray specimens at all.

In Esper's plate several anastomoses of the older branches of the colony are clearly shown, but Thomson and Simpson state that in their specimen there was " no hint of anastomoses ". Toeplitz (1929, p. 366) referred the *G. granulata* of Thomson and Simpson to the species *G. miniacea* because it had no anastomoses, and Esper's species to *G. umbraculum* because it had anastomoses. If Toeplitz's classification is to be accepted, and the species of *Gorgonella* be determined arbitrarily on the presence or absence of anastomoses, the fragments from the coast of Arabia cannot be identified, because it is not known whether the whole colony, from which they were broken off, did or did not form a network in its main branches.

It is clear from these remarks that the classification of the species of *Gorgonella* is in a most unsatisfactory condition and that a thorough reinvestigation of all the available material is most desirable.

Meanwhile, it is better to refer the specimens described above to Esper's species, which they resemble very closely in form and colour, rather than burden the literature with a new species without an adequate description of a complete specimen.

Genus *Scirpearia* Cuvier (emend).

It is only necessary to say that I agree with Simpson (1910, p. 308) that *Scirpearia*, *Scirpearella* and *Ellisella* should be united into one genus, but I have pleaded already (1932, p. 504) for the retention of *Ctenocella* as a distinct genus.

Scirpearia furcata Hickson (1903, p. 822).

There is a complete specimen and some fragments of Alcyonaria which may be referred to this species from three localities in the collection.

(A) From Station 45, 38 metres, off the coast of Hadramaut. One complete specimen and two fragments.

(B) From Station 89, 193 metres, off Bombay. Two fragments.

(C) From Station 111, 73–165 metres, Pemba Channel. One incomplete specimen.

All the specimens are unbranched.

(A) This specimen, which appears to be complete, is 330 mm. long and has a diameter of 3 mm. for the greater part of its length, but tapers to a fine point at the distal extremity.

The polyps are tightly contracted, so that the verrucæ are almost flush with the surface of the cœnenchym. A deep, narrow groove is seen on both sides of the branches.

Attached to one of the fragments in the same tube there is a white mass of the Tunicate *Didemnun herdmani*.

The colour is brown.

(B) The two fragments are 70 mm. and 60 mm., respectively, in length and 1·5 mm. in diameter. The polyps appear to be very small as compared with those of the specimens, and the verrucæ are not prominent. They have a close resemblance to the figures of an example of this species given by Simpson (1910, pl. xiv, fig. 88) and, as in that specimen, there is a broad band which is not polyp-bearing on one aspect of the colony.

The colour is white.

There is a note in the tube that a specimen of *Scalpellum bengalensis* was attached to this Gorgonian.

(C) The single specimen from this locality is distinguished from the others by its very prominent verrucæ. It is about 210 mm. in length, and its diameter between the verrucæ is 1 mm. The verrucæ are conical in shape and about 1 mm. in height. There is a bare track, with a groove in some places, on one side of colony.

The colour is yellow.

The species *Sc. furcata* was the subject of an extremely valuable investigation by J. J. Simpson (1910, p. 339). He examined the types and co-types of this and other species, and also a very large number of specimens of the genus from various localities in the

Indian Ocean. Moreover, in order to check his results, he made a laborious examination of several regions of one large specimen from Providence Island.

By these means he was able to prove that there is considerable variation, not only in specimens from different localities, but also in the various parts of a single colony. It is evident, therefore, that many of the characters that have been used for the determination of the species of this genus are of little scientific value.

The specimen and fragments from three localities, collected by the Murray Expedition, seemed, at first sight, to belong to three distinct species, but after a careful study of Simpson's detailed description of *Scirpearia furcata* I am convinced that they are only variants of that species.

In 1929 (p. 289) Toeplitz published a revision of the genus which was incorporated into Kükenthal's account of the Gorgonaria in ' Das Tierreich ' (1924, p. 367).

In this classification *Scirpearia furcata* was transferred to the genus *Ellisella* and divided between the species *E. lævis* and *E. maculata*.

Toeplitz did not examine the type or co-types of *Scirpearia furcata* and probably had far less material from the Indian Ocean to investigate than Simpson had. He gave no reasons for his changes in the system, no criticism of Simpson's paper, and entirely ignored the probabilities of variation in his species.

For these reasons the paper by Simpson should be regarded as the standard work on the subject in preference to any other.

Nicella reticulata Thomson and Simpson (1909, p. 266). (Pl. I, fig. 1.)

Station 111, 73–165 metres, Pemba Channel.

A large number of specimens which may be attributed to this species were dredged at Station 111. They are all of great size, the largest, although not quite complete, is 215 mm. in height by 150 mm. in width. As there is no base of attachment on any of them, there is no evidence of the length of the main stem. The rest of the colony is strictly flabellate in growth and there are numerous anastomoses. The size of the meshes is very variable, but they are usually oblong in shape and about 40 mm. long by 10 mm. in breadth. All the branches are round in section and exhibit no shallow grooves on either side. They are about 5 mm. in diameter in the middle of the flabellum and the terminal branches taper to a fine-pointed extremity. The verrucæ are very numerous, scattered all round the branches, about 1 mm. in diameter and only slightly raised above the level of the cœnenchym.

The axis is brown in colour and, in the larger branches, scored at the surface by numerous fine, slightly spiral, longitudinal grooves. It is highly calcified.

Spicules.—The surface of the cœnenchym bears numerous very small double stars and capstans, which give it a very finely granular appearance when examined with a 1-inch objective. These spicules are about 0·03 mm. in length. Below the immediate surface a few small spindles make their appearance, and these increase in number and in size as the internal region is reached.

Most of these spindles are sharp-pointed and provided with 5–7 girdles of prominent tubercles. The largest of them are about 0·2 mm. in length.

A description of the calyx cannot be given as the polyps are very strongly contracted, and the specimens themselves show some signs of having been dead or moribund when

captured. Some preparations of the shrivelled polyps, however, show that there is a crown of slender, bent spindles and points of thicker bent spindles. All the spindles in these polyps show tubercles that are not so regularly arranged in girdles as are those of the cœnenchym.

The type specimens of this species were described by Thomson and Simpson, and came from the Persian Gulf in 88–89 metres, and from the Laccadives in 54–91 metres. Like the specimens described above, they were of great size, a typical colony measuring 270 mm. in height by 160 mm. in greatest breadth.

The specimens from Pemba Channel do not entirely agree with the description of the type. In many of the branches of the type the polyps are mainly arranged in two rows and the surface bears longitudinal furrows, which are sinuous and sometimes almost spirally twisted. Moreover, the small double star or capstan spicules are larger and the spindles are much smaller than in the Pemba specimens.

Most of Thomson and Simpson's specimens had a variable brick-red to vermilion colour, whereas the Murray specimens were uniformly pale brown and all the spicules were white.

Notwithstanding these divergences from the type, the Murray specimens should, in my opinion, be referred to this species.

The presence of longitudinal grooves on the branches does not seem to be a trustworthy character for making specific distinctions because it is very variable, even on a single specimen, and may be due to the activities of epizoic Crustacea.

If this identification is correct the species has a wide distribution in the Indian Ocean and seems to be abundant in some localities. It occurs in the Red Sea, the Persian Gulf, on the east coast of Africa and in the Laccadive Archipelago.

Nicella reticulata ? Thompson and Simpson (1909, p. 266).

There are two fragments of Gorgonellids in the collection which may be referred provisionally to this species.

One of them came from Station 10, 55 metres, in the Red Sea, which will be referred to as Specimen A ; and the other from Station 43, 95 metres, off the coast of Hadramaut, which will be referred to as Specimen B.

Specimen A : This colony is very lax in growth with very few anastomoses. The branches are slender and some of them are not in the plane of the flabellum. The size of the fragment is 60 mm. by 60 mm. The polyps are represented by low mound-like verrucæ and are situated unevenly all round the branches.

Most of the spicules in the preparations are long, pointed spindles 0·2–0·3 mm. in length, but there are several double clubs or capstans about 0·04 mm. in length.

Although these spicules resemble very closely those of the specimens from the Pemba Channel, the spindles are much more numerous and the double clubs are comparatively few in number.

The colour is very faintly pink.

Specimen B : This fragment, 50 mm. by 50 mm. in size, shows a much closer mesh-work of anastomoses than Specimen A. The branches are also very slender and circular in section.

The verrucæ are prominent (0·4 mm. in height), conical in shape and irregularly distributed.

The colour is pale red.

The spicules of this specimen present a very different appearance to those of the other one. There are very few small double stars less than 0·07 mm. in length and I have found no spindles over 0·1 mm. in length. Most of the spicules in a preparation are small double clubs of various sizes up to a maximum of 0·1 mm. in length.

It may be considered doubtful if these two fragments should be referred to the species *Nicella reticulata*. The loosely-built flabellum of A and the pale red colour and prominent verrucæ of B give them a very different external appearance from the typical examples of this species and from one another.

They agree with *N. reticulata* in the presence of anastomoses and in a general resemblance between the two characteristic types of spicules. Specimen A is, in my opinion, undoubtedly a *Nicella reticulata*, and the difference between it and the Pemba Channel specimens may be correlated with some environmental conditions in the two localities, the closer meshwork of the anastomoses being often associated with stronger currents of water than more loosely-built flabella.

The position of specimen B is more doubtful. The small size of the spicules suggest that it is related to the genus *Gorgonella*, but in form they are unlike the spicules of any species of that genus I have examined.

It may be that this specimen is only a part of a very young specimen of a *Nicella* or possibly of a *Gorgonella*, but the difficulty of distinguishing small slender fragments of the two genera is almost insuperable and will be until a series of growth stages can be obtained.

Family Primnoidæ.

Stachyodes allmani Wright and Studer.

Calypterinus allmani W. and S., 1889, p. 53.

Station 158, 918 metres, Maldives. Station 159, 1280 metres, Maldives. Station 42, 1415 metres, Hadramaut.

A large jar was filled with numerous specimens and fragments from Station 159. The largest of those with the disc of attachment intact varied in height from 130–265 mm. with a maximum expanse of 120 mm. The branching is dichotomous and definitely in one plane. The number of branches varies considerably. One specimen, 170 mm. in height, has only one simple branch, but most of the complete specimens bear 15 to 20 terminal branches.

The main stem, for a distance of 20–30 mm. from the base of attachment, is 4 mm. or more in diameter and bears no cœnenchym in any of the specimens. The surface of the axis is marked by numerous ridges arranged with a slight spiral twist. The polyps are arranged in definite whorls 2 or 3 mm. apart. On the secondary and terminal branches the whorls are closer together than on the primary branches and usually bear 4 or 5 polyps as compared with 4 or 3 on the proximal parts of the colony.

The polyps vary considerably in size from a total length of 4 mm. on the primary branches to 3 or 2 mm. on the secondary or terminal branches. On the terminal branches the polyps have a distinct flexure downwards, *i. e.* towards the root. In the larger branches

this flexure is not so pronounced, and on some of the primaries the polyps stand out almost straight.

It is not necessary to give a detailed account of the scales of these polyps as they agree fully with those of the type as described and figured by Versluys (1906*a*, p. 93), but an examination shows clearly the large wing-like expansions of the basal scales and the spine on the median scales which constitute important characters of the species.

The axis consists of alternate laminæ of a horny substance and a granular calcareous deposit, so that on examining a number of axes from different branches some have a smooth iridescent, others a chalky, surface. On the main stem, however, the outermost layer of chalky substance is much thicker and more compact than on any of the branches, and its surface is scored by spiral ridges.

The fragments from the south coast of Arabia (Station 42) clearly belong to the same species.

The best account of this species is by Versluys (1906*a*, p. 92), who examined the type specimen and gave some accurate figures of the armature of the polyps.

According to this author two important features of the species are the wing-like, lateral expansions of the basal scales and a spine-like projection of variable length from the anterior border of the median scales. In these characters the specimens from the Maldives agree very closely with the type.

The locality for the type of this species given in the Report of the "Challenger" Expedition is "Fiji reefs", but as it is very improbable that it grew in shallow water, and as other gross mistakes in the localities of the "Challenger" specimens were made (see Hickson, 1937*a*, p. 97), it would be better to regard the habitat of this type as unknown.

Specimens named *S. allmani* have been recorded from other localities. Those collected by the "Caudan" Expedition in the Bay of Biscay, as shown by Versluys (1906*a*, p. 93), belong to quite a different species, and those collected by the "Prince of Monaco" in the Atlantic could not be referred to this species by Thomson (1927, p. 29) "without great hesitation".

The figures given by Thomson and Henderson (1906, pl. ii, fig. 4) of fragments of the species from the Laccadive Sea in 703 fathoms are satisfactory, although probably upside down.

The species is also recorded by Thomson and Russell (1909, p. 142) from deep water off Saya de Malha and Providence Island, but it should be noted that the base of attachment of their specimen, as described and figured, is quite distinct from that of any specimen in the Murray collection.

In conclusion it may be said that the only certain locality for this species is the seas round the Maldive and Laccadive Archipelagos at depths of 300–900 fathoms.

Thouarella flabellata Kükenthal (1919, p. 418).

Thouarella (*Euthouarella*) *flabellata* Kükenthal, 1924, p. 294.

Station 158, 914 metres; Station 159, 1280 metres; Maldives.

There are two large tubes containing examples of this species, one with a single specimen from Station 158, the other with two almost complete specimens and numerous fragments from Station 159.

The most perfect specimen is about 300 mm. in height. The base of attachment, from which the main stem rises, is covered with a thick coat of non-spicular calcareous substance. It consists of a spreading plate, partly broken away, but over 25 mm. in diameter, from the centre of which rises a thick bead-like swelling 5 mm. in diameter. In this bead the stem forks into two main branches which are themselves almost free from the chalky substance of the base.

There is an indication of a similar structure at the base of the type specimen shown in Kükenthal's beautiful photograph (1919, pl. lxii).

The two main branches each give rise to three or four long secondaries arranged proximately in one plane and these support numerous slender terminals arranged quite irregularly round the branches. These slender terminals are about 20 to 40 mm. in length.

In the processes of capture and preservation a great many of the polyps have become detached, leaving many of the terminal branchlets and parts of the main branches with nothing but the bare axis. This makes it difficult to visualize the exact arrangement of the polyps in life, but it seems to be much less regular than in most of the Primnoids. On some of the terminals, which seem to be well preserved, I have counted five whorls in 10 mm. of length with two or three polyps in each whorl, as in the type ; but some of the secondary branches the polyps are not arranged in whorls and often in thick clusters or irregularly scattered about.

The largest polyps are almost cylindrical in shape and about 1·2 mm. in height by 0·35 mm. in diameter.

They are protected by scales arranged in a manner similar to that of the type as shown by Kükenthal (1919, p. 419). He gives the size of these scales as 0·3–0·36 mm. in breadth. This is in agreement with the scales of some of the larger polyps of the Maldive specimens.

The marginal scales are provided with a long spine, which is very brittle and frequently broken off at the tip. In some scales, however, it is 0·45 mm. in length.

The axis of the terminal twigs is 0·15 mm., and of the branches supporting them 0·6 mm. in diameter. All these branches of the axis have a glistening brown colour, but when placed in an acid give a strong reaction, showing that they are heavily laden with calcareous matter.

On the surface of the axis of some of the larger branches there is a thin chalky deposit, corresponding with the thick layer of this substance on the base of attachment.

All parts of the axis show shallow longitudinal grooves at the surface.

The type of this species was found by the " Valdivia " Expedition in 1644 metres off the East African coast, and this single specimen was well described by Kükenthal.

Thomson and Henderson (1906, p. 42) gave to some fragments of this genus from 703 metres in the Laccadive Seas the name *Thouarella moseleyi* var. *spicata*. This variety was said to differ from the type of *T. moseleyi*, which was dredged by the " Challenger " Expedition in 600 fathoms, by several characters, and it is by some of these characters that it resembles more closely the Murray specimens of *T. flabellata*.

There can be little doubt that the specimens obtained by the " Investigator ", " Valdivia " and Murray Expeditions from the Indian Ocean all belong to the same species, and that that species is the only one of the genus from those waters of which we have any record.

Genus *Caligorgia* Gray, 1857.*

Although some of the species of this genus have a superficial resemblance to some of the species of *Primnoella*, it seems to be quite well-defined by the prominent spined opercular scales and by the elaborate ornamentation of the other scales of the verrucæ.

It is, however, a most difficult genus for the identification of its species. No less than thirty species have been described from nearly all the seas of the world, and one of them—*C. flabellum*—seems to have a cosmopolitan distribution. Six of these species have been described from the Indian Ocean.

No information has yet been obtained about the growth-stages of any one species, nor any careful study made of the extent of variation in an individual colony or series of colonies from the same locality. The result is that many of the characters given for the distinction of species are obviously artificial and misleading.

Caligorgia indica Thomson and Henderson.

C. indica Thomson and Henderson, 1906, p. 43.

Station 157, 229 metres, Maldives.

One perfect specimen and a few fragments were obtained at this station.

The former is 180 mm. in height and 150 mm. in breadth, and in form it is a perfect flabellum. The general appearance of the branches is feathery, but as some of the larger ones are dichotomous and the smaller branches which support the terminals are not straight but zig-zag, the branching is, I suppose, technically dichotomous.

The polyps are not more than 1 mm. in length. They are arranged laterally in pairs, but in some places an additional polyp makes with the others a whorl of three.

There are 7–8 of these pairs in 10 mm. of the length of the branch.

Only a part of the base of attachment is preserved, in the form of a bulbous expansion (5 mm. in diameter) at the end of the main stem, which is covered by a thick calcareous coat, as in *Thouarella flabellata*.

I have not studied the characters of the verrucæ very thoroughly because they seem to agree very fully with the description of the type given by Versluys in Thomson and Henderson's paper (1906, p. 43).

There are, however, 7 scales on the abaxial vertical rows, and the number of scales on the outer lateral rows is reduced to 3 or 4. The opercular scales are prolonged into a spine-like process and have a total length of about 0·4 mm., and the plate-like base a diameter of about 0·3 mm.

The type of this species was found in the Andaman Archipelago at a depth of 73–502 metres, but Thomson and Simpson (1909, p. 180) subsequently described a specimen of the same species from a depth of 54–90 metres in the Laccadive archipelago.

The type specimen was submitted to Versluys for examination, who compared it with the closely-allied species *C. similis* but considered it to be distinct (see Thomson and Henderson, 1906, p. 43).

I am inclined to think, however, that both these species will prove to be only local varieties of the widespread species *C. flabellum*.

* For the story of the spelling of this generic name see Wright and Studer, 1889, p. 75.

Caligorgia flabellum Ehrenberg.

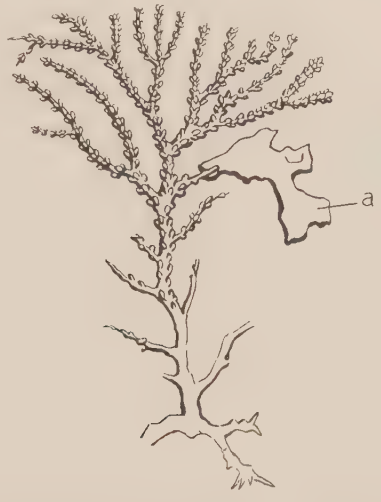
Prymnoa flabellum Ehrenberg, 1834, p. 358.

Station 24, 73–220 metres, off Cape Guardafui.

This very interesting specimen is only 50 mm. in height by about 40 mm. in width (Text-fig. 9).

The base of attachment is fixed to the horny branch of a specimen of the hydroid Ceratella, and from it rises a bare stem bearing seven short dead or moribund branches. At its distal end it divides and gives rise by dichotomous branching to a perfect little flabellum.

One branch has been partly smothered by a colony of Polyzoa (Cellepora ?).



Text-fig. 9.—*Caligorgia flabellum*. *a*, A branch overgrown by Cellepora. Nat. size.

The polyps are arranged in whorls of 4 or 5, and there are 6–8 whorls on 1 cm. of a branch. They are about 1·3 mm. in length as they are adaxially bent.

The scales on the abaxial side bear a pattern of ridges and spines very similar to those shown by Versluys in his text-figure (1906*a*, fig. 77, p. 70).

There may be some doubt as to the identity of this specimen on account of its dichotomous branching. It is, however, a very small and probably young form, and there is no evidence, at present, as to the early stages of growth of any species of the genus.

C. flabellum may attain to a great size. A specimen examined by Versluys was 1 metre in height, and other specimens that have been referred to the species were said to be of large dimensions. In all these specimens and many fragments the branching was feather-like (" federartig "), but this description is based principally on the character of terminal branches of large specimens, and it is possible that in the early stages the branching is dichotomous.

The characters of the scales, the numbers of polyps in a whorl and the size of the polyps are probably more reliable characters for the determination of species, and in these respects the small specimen from Station 24 is most closely related to the widespread species *C. flabellum*.

Caligorgia dubia sp. ? Thomson and Henderson (Pl. I, fig. 2.)

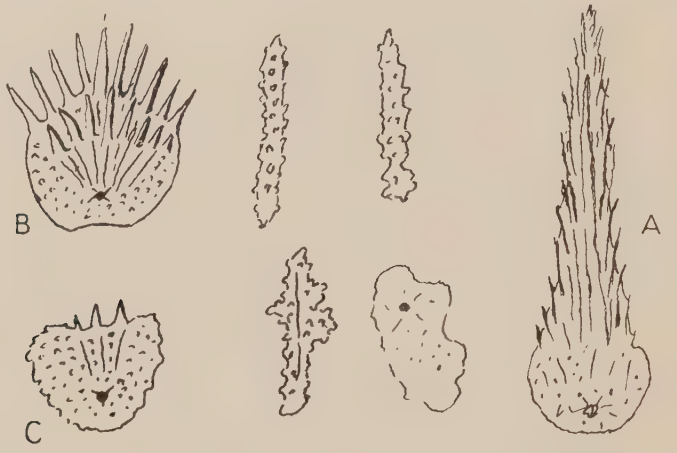
C. dubia Thomson and Henderson, 1906, p. 45.

Station 143, 797 metres, Maldives.

This specimen is referred, with some hesitation, to the species proposed by Thomson and Henderson for a fragment obtained by the "Investigator" in 732 metres in the southern part of the Bay of Bengal.

It is also only a fragment, as the main stem and base of attachment are missing. It is 95 mm. in height and gives off from the stem very slender branches, alternately right and left in one plane. There are twelve terminal branches and the longest of these is 40 mm. in length.

The polyps are about 1 mm. in total length and the cœnenchym between them is very



Text-fig. 10.—*Caligorgia dubia.* A, A scale at the margin of a verruca; B and C, other scales on the verrucæ; D, E, F, G, spicules of the cœnenchym. × 200 diams.

thin and transparent. Considerable damage was done to this delicate structure in the processes of capture and preservation, many polyps and parts of the cœnenchym being lost; but judging from the best preserved branches the polyps are arranged in regular whorls of two or three about 1 mm. apart and in some places odd polyps are found.

The abaxial side of the verrucæ is protected by 7 or 8 rows of overlapping scales in addition to the long-spined scales at the distal end which together form the operculum.

Each transverse row consists of 4 scales which, in the contracted condition, overlap laterally.

The number of the opercular scales seems to vary in different polyps, but the maximum number with prominent spines I have been able to count is five.

They vary also considerably in size and in proportions. In one such spicule, which may be considered to be typical, the total length is 0·4 mm., the spine being about 0·3 mm. in length and the base 0·1 mm. in diameter. The most characteristic feature of these scales is the spine, which seems to be composed of a process of the base of the scale bearing numerous diverging ridges produced laterally into small tooth-like spinelets at the edges (Text-fig 10, A).

The scales of the row immediately below the operculum (Text-fig. 10, B) are 0·2–0·3

mm. in diameter, are ornamented with 7 or 8 pronounced ridges diverging from a common centre and terminating distally in one or two rows of prominent spines.

In the succeeding rows the scales are reduced in size and the number of the ridges and spines fewer and less prominent (Text-fig. 10, c). On all these scales the surface is dotted with minute tubercles.

The surface of the cœnenchym between the verrucæ is protected by flat tuberculate scales closely fitted together to form a complete armour. When separated they are seen to have an infinite variety of shapes (Text-fig. 10, d–g).

The axis is round in section and has a rough and rather granular surface. At the base of a terminal branch it is about 0·3 mm. in diameter, but tapers off at the end to a very fine thread.

The colour of the colony is very pale yellow.

The description of the type of this species was not very full and was not illustrated by any figures or diagrams. It was 79 mm. in height. But our specimen agrees with the type in the number of polyps in a whorl, the size of their scales, the presence of spines on their margins, the long spine on the opercular scales and in some other minor characters.

Species that are founded on fragments only are notoriously unsatisfactory ; but on comparing this specimen from Station 143 with the other two species from the Indian Ocean I have examined, it seems to be undoubtedly distinct and that, most probably, it belongs to the species described by Thomson and Henderson.

The only other species which shows opercular spicules comparable with those of the Maldive species is *C. formosa*, described by Kükenthal (1919, p. 368) from the Nicobar Islands in 362–750 metres ; but this species differs from it very markedly in the characters of the other scales of the verrucæ.

Family Acanthogorgiidæ.

Acanthogorgia muricata Verrill (1883, p. 34).

There were specimens of *Acanthogorgia* in the collection from three stations. From Station 43, off the south coast of Hadramaut, in 95 metres, there were seven colonies ranging in height from 50–120 mm. Five of these were complete, bearing a small disc of attachment.

The ramification is, in all cases, in one plane, and most of the branches stand out at right angles to the main stem.

The long slender polyps are close-set all round the branches, with an average height of 5 mm. from the base of the verrucæ to its spiny margin. In all cases the anthocodiæ are completely retracted into the verrucæ. The diameter of the body of the verrucæ is about 0·9 mm., but the margin is a little more expanded.

The long bent spindles of the body wall are arranged more or less *en chevron*.

The number of spines projecting from the margin cannot be accurately counted because some of them are broken off and lost ; but there must be at least 12 on most of the verrucæ.

The spicules are all white and have the usual form of the species of the genus.

From Station 157, off the Maldives, in 229 metres, a few fragments only were obtained and are preserved in a bottle containing many specimens of *Bebryce mollis*.

The polyps are much more crowded together in these fragments and, as they are preserved, a good deal smaller, being only 3 mm. in height by about 0·9 mm. in diameter.

There is no difference of any importance between the spicules of these specimens and those from Station 43.

These fragments probably belong to the same variety as those described by Thomson and Henderson (1905, p. 290) from Trincomalee under the name *A. muricata* var. *indica*.

From Station 24, off Cape Guardafui, in 73–220 metres, there is a small but complete specimen of the same species.

The height of the specimen is only 70 mm. and the main stem bears nine branches which are almost exactly bilaterally arranged. The longest branch is 40 mm. in length and bears no branchlets. Of the other eight, only one bears lateral branchlets.

The polyps are smaller than those of the specimens from the other localities, being only 2 mm. in height and about 0·8 mm. in diameter. The spicules and their arrangement on the walls of the polyps cannot be distinguished from those of more typical examples.

Sir Arthur Thomson and his partners are responsible for referring an Indian Ocean species of *Acanthogorgia* to Verrill's species *A. muricata*, described from specimens obtained off Barbados. If this identification is correct the species has a remarkably wide distribution extending from the Indian Ocean, through the Mediterranean Sea to the Atlantic Ocean and the West Indies.

Thomson and Simpson (1909, p. 192), after an examination of a large number of examples of this species collected from various localities extending from the Andaman Islands to the Red Sea, came to the conclusion that the species is very variable and that "many of the characters on which new species (of this genus) have been formed are of doubtful significance." On this ground, therefore, it seems probable that the reference of these specimens to Verrill's species is sound.

In a recent publication, however, Deichmann (1936, p. 151) expresses the opinion that *A. muricata* is identical with *Blepharogorgia schrammi* of Duchassaing and Michelotti. Gray's genus *Acanthogorgia* (1857) has priority over *Blepharogorgia* (1864), and therefore the name of the species would become *Acanthogorgia schrammi*.

In my opinion this very inconvenient change of name should not be adopted until the authenticated type specimen of *Blepharogorgia schrammi* has been found and re-investigated.

The name given to the genotype by Gray (1857, p. 128) was *Acanthogorgia hirsuta*.* Unfortunately, its locality was unknown; but it is possible that it came from the West Indies and is identical with *A. schrammi*.

Family Chrysogorgiidæ Verrill, 1883, p. 21.

Dasygorgiidæ Wright and Studer, 1889, p. 1.
Chrysogorgiidæ Versluys, 1902, p. 2.

This family of deep-sea Gorgonacea includes six well-defined genera and one (*Metallogorgia*) which may be considered to be of doubtful significance (see p. 308).

It is represented in the collection by two species of *Chrysogorgia* and two species of *Radiceps*.

* The only figure of *A. hirsuta* was published in the 'Proceedings of the Zoological Society', 1851, pl. iii, but, owing to a mistake of the artist, under a different name. It is remarkable that the genus *Acanthogorgia* is not mentioned in Gray's 'Catalogue of the Lithophytes in the British Museum', 1870.

There has been in past years some doubt as to the proper name of the Family. Wright and Studer, having expressed some uncertainty as to the systematic position of the type species *Chrysogorgia desbonni* (D. and M.), changed the family name to Dasygorgiidæ ; but Versluys, having proved that the species referred to—*Dasygorgia*—cannot be separated from *Chrysogorgia*, restored the older family name. Finally, Deichmann (1936, p. 228), having examined a large number of specimens of *Chrysogorgia desbonni* in the Harvard Museum, confirmed Versluys' views, and the family name Chrysogorgiidæ is now generally accepted.

Genus *Chrysogorgia* Duchassaing and Michelotti.

Dasygorgia Verrill, 1883, p. 21.

This genus is represented in the collection by specimens dredged at four stations off the Maldive Archipelago at depths of 256–1280 metres and from two stations off the coast of Arabia at depths of 1046–1450 metres, which are referred to the species *Chrysogorgia flexilis* ; and from one station off the Maldive Archipelago in 225 metres, which are referred to *Chrysogorgia cupressa*.

Most of the seventy specimens of *C. cupressa* are complete with a stalk of attachment, *C. flexilis* is represented by only two specimens that are approximately complete, and by numerous fragments of various sizes.

There are exceptional difficulties in the identification of the species of this genus and in separating some of them from Versluys' genus *Metallogorgia*.

No less than fifty named species of *Chrysogorgia* are mentioned in Kükenthal's monograph (1924), and many of these have been described from single specimens or fragments, and therefore important specific characters are, in many cases, unknown.

No consideration seems to have been paid by previous authors to the possibilities of variation in the species or in the individual, and the characters of the species seems to have been based on the examination of only one polyp or of a small branch.

Some of these characters are of very questionable value ; for example, such a statement as that the spicules are pointed spindles and of certain length in millimetres in one species and that in another they are rod-shaped and of a smaller or greater length.

In all the preparations I have made there is an immense variety in the shape and size of the spicules. In some the spindle-shaped spicules may predominate over the rods, or vice versa, but I have never found any preparation without some spindles and some rods. The difficulty of describing accurately any one spicule preparation may be appreciated by a glance at the figures given by Wright and Studer (1889, pl. v) of the spicules of several species of *Chrysogorgia* (=*Dasygorgia*). These figures seem to have been drawn at random by an artist and they show no definite characters by which one species could be distinguished from another. In many groups of Alcyonaria each species has its own characteristic spicules. No such spicules are found in *Chrysogorgia*.

The height of the polyps is often given as a diagnostic character of a species. What does this mean ? It is probable that no polyp with the anthocodia fully expanded has yet been seen and, consequently, this measurement can only refer to that part of the body-wall which is strengthened by an armature of spicules, the verruca. But this varies enormously in size in every specimen.

The largest polyps in any specimen, preserved in spirit, are usually those that are

pregnant with gonads. They are more or less cylindrical in shape with a swelling at the base or higher up, wherever the gonads are situated. The spicules are arranged longitudinally and frequently form triangular points at the distal margin. Such points are well shown in Kükenthal's figure of *Chrysogorgia flexilis* (1919, text-fig. 230, p. 519). On the same branch may be found polyps that are not pregnant, with the body-wall contracted to form a low mound, one quarter or less than the height of the pregnant polyp, and in such a condition the spicules are arranged transversely or more or less irregularly, no points being visible. Between these two forms many intermediates can be found.

Another great difficulty is to distinguish between the genera *Metallogorgia* and *Chrysogorgia*. The name *Metallogorgia* was given to the genus by Versluys (1902, p. 87) on account of the brilliant metallic colours of the axis of its stem and branches. But this character is by no means confined to the two species of this genus. In all the specimens of *Chrysogorgia* collected by the Murray Expedition the surface of the axis has a metallic iridescence similar to, but not always so brilliant as, that of *Metallogorgia*. This character is not, therefore, a reliable one for the genus.

In all the descriptions of the species attributed to the genus *Metallogorgia* (see Versluys, 1902, p. 88 ; Kükenthal, 1924, p. 388) the colony is supported by a long stem, up to 730 mm. in length, which bears only a few small or very rudimentary barren branches. At the top, this stem divides either dichotomously or in two almost equal branches, which subdivide and give rise to the great racemose mass of the colony.

This kind of stem was called by Versluys " monopodial " to distinguish it from the stem of *Chrysogorgia*, which he called " sympodial " ; and, according to this author, affords the only character which distinguishes the two genera.

It is the character given by Kükenthal (1924, p. 383) in his key index as a guide to the zoologist.

When the stem divides at its upper end into two equal or sub-equal branches and gives rise to much ramification, the method of branching becomes sympodial (Versluys, 1902, p. 87), as it is in *Chrysogorgia*.

Consequently, specimens without a stem and fragments of colonies above the stem have lost the only character which distinguishes *Metallogorgia* from *Chrysogorgia*, and the systematist cannot possibly tell, with any degree of certainty, to which genus such specimens should be referred.

In this collection, made by the Murray Expedition from seven different stations, only two stems with the discs of attachment are preserved (leaving out of consideration for the moment the specimens of *Chrysogorgia cupressa*). One of these has the appearance of a stem of a *Metallogorgia*, the other of a *Chrysogorgia* (Text-fig. 11). A comparison of these two stems suggests that there is, in reality, no essential difference between a " monopodial " and a " sympodial " stem.

These two specimens were found at Stations 159, 1280 metres, and 158, 914 metres, respectively, both close together, west of the Maldive Archipelago. In the following paragraphs they will be referred to simply as 159 and 158, respectively.

In 159 a part of the stalk bearing the base of attachment has been broken off in preservation. This is 150 mm. in length, but another part 180 mm. in length remains attached to the bushy expansion. Assuming, then, that nothing has been lost, the total length of the stalk was 330 mm. in length. This very long slender stalk varies very little from 1 mm. in diameter throughout its length. The stalk of 158 has a total length of 120

mm. and its diameter is almost uniformly 2 mm. At first sight there can be no doubt that the stalk of 159 would be referred to *Metallogorgia* and that of 158 to *Chrysogorgia*.

But the striking differences they show seem to lose their importance when they are more closely examined.

On both there is a series of small spine-like processes, which undoubtedly are remains of branches which were present in the earlier growth-stages of the colony.

In 158 these processes are arranged spirally at distances of 3–8 mm. apart. In 159 they are very much smaller and situated at distances of 8–10 mm. apart. In both there is a slight bend or kink in the stem opposite the point of origin of the processes, but this bend is much more pronounced in 158 than in 159.

I have not been able to determine whether the axis cylinder of these branches is or is

TEXT-FIG. 11.—*Chrysogorgia flexilis*. Stems of specimen from Station 158 (left) and from Station 159 (right). × ⅔ length.

not continuous with that of the main stem, but on comparing the figures of the stems of *M. melanotrichos* given by Versluys with those of *M. macrospina* by Kükenthal and the two stems shown in Text-fig. 11 from the Murray collection, it is very difficult to believe that there is really any essential difference between the so-called "monopodial" and "sympodial" type of stem.

For these reasons, therefore, I have referred both the specimens from Stations 158 and 159 to the genus *Chrysogorgia*.

It is fortunate that in both of them a part of the base of attachment is present. In 158 it is quite irregular in shape, with a greatest expanse in one direction of 10 mm. In 159 it is much smaller, with a greatest expanse of only 5 mm. In both the surface is marked by numerous shallow grooves radiating from the place where the horny stem plunges into a thick calcareous mass. On treating a fragment of the base with H.Cl. there is a small residue consisting of a spongy mass of a substance which may be horny. The calcareous substance is quite amorphous. There are no spicules in it.

If these were the only two specimens in the collection they would undoubtedly be regarded as representatives of two distinct species for the following reasons :

The branching of 158 is much denser than it is in 159, the axis of the branches are thicker, the internodes shorter, and the polyps on the terminal branchlets more numerous.

It is impossible to reduce these statements to exact figures, but it may be said that the proximal ends of the branches of 158 are 1·5–2 mm., and of 159 are not more than 1 mm. in diameter, the internodes of the former are rarely more than 10 mm. in length, of the latter many are 30 mm. or more in length.

The least retracted polyps of 158 are smaller than those of 159 and the armature of spicules is mainly composed of small rods instead of long spindles, but there is such a big range in the size of the polyps even on a single branch of either specimen due to age or to a condition of pregnancy that any figure that may be given of the actual size must be taken with some reserve.

The largest pregnant polyp of 158 in my preparations is 1·3 mm. and of 159 2·5 mm. in height. These figures may be taken to represent roughly the difference in size between the polyps of the two specimens.

The body-wall of these two polyps is protected by an armature of spicules which in 158 are mainly rods with rounded extremities and a maximum length of about 0·4 mm., and in 159 long spindles with a maximum length of about 0·9 mm. (Text-fig. 12). In 158 the rods are arranged somewhat irregularly and mainly parallel to the long axis of the polyp ; in 159 the spindles are much more regularly arranged in the same direction, and at the distal end form eight triangular groups similar to the points of the calyx of other Alcyonaria (see Kükenthal's figure of *C. flexilis*, 1919, p. 519). When these characters, however, of the two polyps are compared with other polyps of the same specimens, so many different arrangements of the spicules are found that it is difficult to define accurately what are the essential differences between them.

None of the polyps are fully expanded. All that we have to examine are different stages of contraction, and as the contraction was probably rapid and unnatural the spicules have become more or less distorted in most of them. If we compare the figures of the polyps of *Chrysogorgia flexilis* given by Wright and Studer (pl. iv, fig. 2), by Versluys (p. 46, fig. 63) and by Kükenthal (p. 519, fig. 230) it is seen that there is no agreement between these authors as to the pattern of the spicules of the polyps in this species.

The larger size of the spicules of 159 and the difference in shape as compared with those of 158 might suggest that there is a good specific distinction between the two specimens, but in spicule preparations of 158 there are not only the rods of various sizes but several long spindles exactly similar to the characteristic spicules of 159 ; and in preparations of 159 a few rods similar to those of 158 are found among the spindles.

The difference between the armature of the polyps of these two specimens, therefore, is not that the spicules are different but that the proportion of rods and spindles is different.

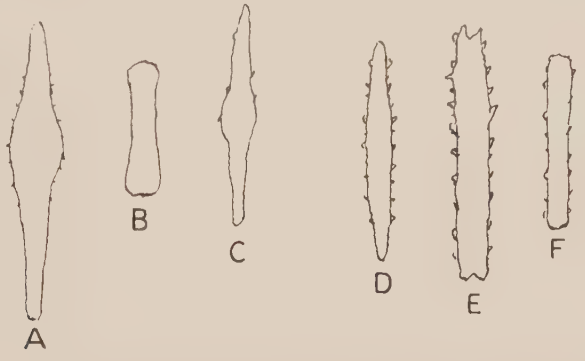
There are, fortunately, in the collection several fragments of specimens from Station 152, 878 metres, and Station 153, 256 metres. They are not so well preserved as the others, the polyps being more tightly contracted. In the density of the branching and in the size and distribution of the polyps they resemble 158 more closely than 159.

The spicules of 152 and 153 are rods very similar in length and shape, but slightly narrower than those of 158. There are, however, in my preparations no long spindles in either specimen.

The fragments from the south coast of Arabia were collected at Stations 42, 1450 metres, and 54, 1046 metres. There can be little doubt that these specimens belong to the same species as those described by Kükenthal (1919, p. 518) as *Chrysogorgia flexilis* var. *africana* from the east coast of Africa in 463–1289 metres of water.

The spicules covering the surface of the polyps of these Arabian specimens are spindles, but of rather a different shape from those of 159 (Text-fig. 12, D). The greatest length of these spicules in 42 is 0·4 mm. and in 54 0·5 mm. The surface of many of these spicules is very rough and in some the minute denticulations are of the size of small tubercles. There is, in this respect, such an immense variation that it is not a good character for the determination of the species.

The problem of the species.—In the Report by Thomson and Henderson (1906, p. 28) specimens of *Chrysogorgia* from the eastern part of the Indian Ocean were referred to five species. All of these, except those called *C. flexilis*, were fragmentary and from one locality only. *C. flexilis* was found at four stations at depths of 700–1110 metres, and one specimen, at least, retained the stem and a small base of attachment (1906, pl. ii, fig. 3).



Text-fig. 12.—Outline sketches of selected spicules of *Chrysogorgia flexilis*. A, From Station 159 with a few small tubercles; B and C, from Station 158 with a smoother outline, the rods more numerous than the spindles; D, E, F, from Station 42 with many small tubercles. All × *circa* 50 diams.

The specimen shown in this figure is closely related to that from Station 159 in the Maldive Archipelago, although the stem is not so long and the spindles covering the polyps a little shorter. The "Valdivia" Expedition obtained eleven specimens from five stations off the east coast of Africa at depths ranging from 463–1289 metres, which Kükenthal (1919, p. 518) called *C. flexilis* var. *africana*. The spicules of this variety, according to the description, are long rods becoming spindles but even smaller than those of Thomson and Henderson's specimen. Nevertheless, they are very similar to those of the Murray specimen from Station 159.

From the study of these specimens Kükenthal (p. 520) came to the conclusion that depth must have some influence on the structure of the colony. There is, for example, a thicker stem and longer internodes in the forms from deeper waters. This statement is not in accordance with my observations on the Murray specimens, in which the forms from deeper water have longer internodes but more slender stems. It is unfortunate that we have no information as to whether there is any variation in the spicules and other characters in the "Valdivia" specimens.

When an attempt is made to give specific names to the numerous specimens of this genus from the Indian Ocean the fact that no two specimens from different depths are

exactly alike as regards some important characters and that in some, such as the size and armature of polyps, considerable variations may be seen on the same branch of a single colony, the question arises whether we are dealing with one variable or a very large number of distinct species.

All these specimens from the Indian Ocean inhabit deep or very deep water, and it is generally recognized now that in other groups of Cœlenterata deep-sea species are very widespread geographically and liable to considerable variation in form and some other characters.

The probability, therefore, is that we are dealing with one species which varies according to the nature of the sea-bottom, the strength and direction of the currents, and other features of the environment in deep water.

A muddy bottom may lead to more rapid growth, producing a longer and more slender stem. Scarcity of food brought by the sea-currents may induce the production of longer internodes and larger and more scattered polyps.

In the forms from less than 1000 metres in depth the stems are usually shorter, the branching more compact and the polyps smaller and more numerous than in those from deeper water, and this may be correlated with lesser mud and stronger sea-currents.

In this connection it may be noted that the specimen of *C. flexilis* var. *africana* shown in Kükenthal's pl. xxxi, fig. 12, came from a depth of only 463 metres and has a much shorter stem than the Murray specimen from Station 159 from 1290 metres, which in many other respects it closely resembles.

If the view be accepted that all these specimens from the Indian Ocean belong to one species the question arises as to which of the species already described they should be assigned. In my opinion they should be referred to the *Chrysogorgia flexilis* of Wright and Studer (1889, p. 10).

The type of this species came from 219 metres off the island of Chiloe on the coast of Chili. Specimens from several stations in the Malay Archipelago were referred to the same species by Versluys (1902, p. 10) and by Thomson and Henderson, and by Kükenthal, as mentioned above, from the Indian Ocean. Like other deep-sea species, therefore, it has a wide distribution in deep water, and there is no reason for separating the Indian Ocean forms from the type, because they are so widely separated geographically.

Chrysogorgia flexilis Wright and Studer.

Dasygorgia flexilis Wright and Studer, 1889, p. 10.

The principal characters of this species are: Colony supported by a long stem rising from a calcareous base of attachment, with barren rudimentary branchlets. Branches long and racemose, arranged in a spiral manner, with long internodes and widely-separated polyps, very slender and flexible. Spicules, spindles and rods with or without small tubercles, and very variable in size and arrangement. Axis smooth with brilliant metallic lustre, covered in life with a very thin cœnenchym bearing a few irregular plates and scales. World-wide distribution in deep water.

From the investigation of the examples of this species collected by the Murray Expedition there appear to be some slight differences between those collected in the Maldive Archipelago and those from the east coast of Africa and South Arabia, and they may, therefore, be separated, provisionally, as local varieties.

C. flexilis var. *africana* Kükenthal.

Most of the spicules spindle-shaped, and some of them provided with minute or small tubercles.

Stations 42, 1450 metres, and 54, 1046 metres.

C. flexilis var. *maldivensis*. New variety.

Most of the spicules rod-shaped and very rarely provided with tubercles.

Stations 152, 153 and 158, 229–914 metres.

The specimen from Station 159 seems to be intermediate between these two varieties.

Chrysogorgia cupressa Wright and Studer (1889, p. 11).

About seventy examples of this species were dredged at Station 157, 229 metres, off the Maldive Archipelago.

Of these only five were complete with a base of attachment. Most of the others seem to have been broken off close to the base of the stalk.

The largest specimen in the collection is 130 mm. in height, but of the five complete specimens the largest is only 60 mm. and the smallest 45 mm. in height.

In a note it is stated that 11 " Munida " crabs, 3 Ophiurids and 1 barnacle were associated with these specimens. To these may be added 2 specimens of *Paracyathus conceptus* which formed the support of two of the colonies of *Chrysogorgia cupressa*.

These solitary corals seem to be very common in deep water off the Maldives (Gardiner and Waugh, 1938, p. 184).

The general form of the colonies is that which has been described as like a " bottle-brush " or, by Wright and Studer, as " a delicately-branched conifer ".

The main stem arising from a small disc of attachment is of variable length, is jointed, and from its upper end the branches spring in a left-handed spiral. There are four branches to each twist of the spiral.

The sub-division of the branches is in a manner similar to that shown in Wright and Studer's diagram, fig. 4 on p. 21 of their monograph.

The spicules are confined to the outer surface of the body of the polyps and to the aboral sides of the tentacles. They are short rods with rounded ends, and are covered with numerous minute denticulations. They vary enormously in size, but the average of a number of the larger ones is about 0·2 mm. in length by 0·028 mm. in breadth. The fig. 45 on p. 21 in Versluys' monograph (1902) is a good representation of such an average spicule.

There are no spicules preserved in the very thin cœnenchym between the polyps.

I have not studied the characters of the verrucæ very thoroughly because they seem to agree very fully with the description of the type given by Versluys (1902, p. 43).

The specimens collected by the Murray Expedition agree very closely with the descriptions given by Wright and Studer and by Versluys (1902, p. 40) of the type of *Chrysogorgia cupressa* from 140 fathoms (252 meters) off the Kei Islands in the Malay Archipelago. The distance between the Kei Islands and the Maldives is undoubtedly very great, but the numerous examples of the widespread distribution of the deep-sea

Alcyonarians affords no reason for supposing that the Murray specimens must belong to a different species from the type.

Versluys has described three new species from the Malay Archipelago which, together with *C. cupressa*, belong to his group Spiculosæ and sub-group A1.

Unfortunately, there was only one specimen of each of these three new species, and consequently Versluys was unable to study the variation in any of them. In the large collection of specimens from the Maldives there is clearly considerable variation in some respects, a thorough study of which might lead to very interesting results. Until this has been done the " Siboga " new species must be accepted with some reserve. One of the species described by Versluys (*C. tetrasticha*) was dredged in the Kei Archipelago in 204 metres of water, that is in the same locality and in approximately the same depth as that in which the type of *C. cupressa* was found. If *C. tetrasticha* is really a distinct species it will be a very exceptional case of two deep-sea species of Alcyonaria, closely related to each other, living in the same locality and in approximately the same depth of water.

Genus *Radiceps* Stearns (1883, p. 97).

Lepidogorgia Verrill, 1884, p. 220.
Strophogorgia Wright and Studer, 1889, p. 3.
Radiceps Kinoshita, 1913, p. 5.

There can be no doubt that Kinoshita was right in giving to the name Radiceps for this genus the right of priority.

Radiceps aureus ? Kükenthal (1919, p. 544).

There is one specimen belonging to this genus from Station 145, 494 metres, Maldives, which I found in a tube containing a number of specimens of *Pennatula inflata*. In general appearance it resembles closely the picture of *Strophogorgia challengeri* given by Wright and Studer (1889, pl. i, fig. 1). It is 260 mm. in length and its diameter in the middle is 1·8 mm. The polyps are arranged in a single row at regular distances of 2 mm. apart. The total length of the two polyps I examined was about 1·5 mm. The needle-like spicules on the abaxial side of the polyps reached a maximum of 0·9 mm. in length.

These polyps have the appearance of having been dead when captured, and it was impossible to determine the characters of their tentacles. The base of attachment is calcareous and gives irregular branches over the support similar to those shown in Wright and Studer's figure on their pl. i, fig. 1, of *Strophogorgia challengeri*.

The type of *R. aureus* was discovered by the " Valdivia " Expedition in 1644 metres of water off the coast of tropical East Africa. Specimens referred to *Radiceps challengeri* were found in deep water in the Atlantic Ocean.

In his key-index to the species of the genus, Kükenthal (1924, p. 410) gives as a distinction between the two species that the abaxial tentacle is rudimentary in *R. challengeri*, but not rudimentary in *R. aureus*. This is a character which could not be determined in the Murray specimen.

The two species are closely related, as also is *R. verrilli*, of which a specimen has been described from the Andaman Islands in 685 metres by Thomson and Henderson (1906, p. 26).

I have put a mark of interrogation after the specific name of the Murray specimen because on the evidence it might belong to any one of these three species.

Radiceps squamiferus Kükenthal (1919, p. 545).

Station 106, 212 metres, Pemba Channel.

One example of this species, 100 mm. in length with a diameter of 0·4 mm., was found in the same region in which the type specimens were discovered by the "Valdivia" Expedition. It agrees so closely with the excellent description of the type given by Kükenthal that, beyond making one preparation of two polyps, I have not thought it worth while to make any further examination.

Kükenthal was able to study ten specimens from off Dar-es-Salaam and four from the Zanzibar Channel in 463 metres.

Order PENNATULACEA.

Kophobelemnon pauciflorum Hickson (1916, p. 72).

A single rather damaged example of this species was obtained from Station 171, south-west off Cape Guardafui in 3872 metres of water. It is about 120 mm. in total length and bears only three large autozooids.

There is an abundance of spicules in the tentacles and in the outer layers of the rachis. All these spicules are ridged needles with a maximum length of about 1 mm.

The genus *Kophobelemnon* does not appear to be common in the Indian Ocean, and it therefore seemed to be of interest to record the existence of this specimen, which was inadvertently omitted from my monograph of the Pennatulacea of the Murray Expedition.

K. burgeri was described by Thomson and Henderson (1906, p. 88) from 170 metres in 13° N. by 80° E., and a new species by Thomson and Simpson (1909, p. 277) called *K. intermedium* in 95 metres in the Gulf of Martaban.

The latter was considered to be intermediate in some respects between the genera *Kophobelemnon* and *Sclerobelemnon* on account of the absence of spicules in the tentacles. The specimen described above differs from this species in having numerous spicules in the tentacles, and from *K. burgeri* in having very few autozooids.

It agrees very closely with the species *K. pauciflorum*, which seems to be fairly common in the Malay Archipelago (Hickson, 1916, p. 72).

Anthoptilum inermis Thomson and Henderson (1906, p. 91).

There is one, damaged and badly preserved, specimen in the collection from Station 70, 196 metres, off the coast of Hadramaut, which is probably identical with the species described by Thomson and Henderson under the generic name *Thesioides*.

It is a very slender form with a total length of about 170 mm. and the greatest diameter of the rachis is 0·6 mm. Some of the autozooids are isolated or in pairs, but there are one or two places in which there seem to be leaves of three or four polyps. The specimen, however, is so damaged that it is impossible to determine exactly what the normal condition was like.

No spicules were found in either the autozooids or in the rachis.

The type specimens of *Thesioides* were found in the eastern part of the Indian Ocean at depths of 818–845 metres.

The genus has been transferred to *Anthoptilum* (see Hickson, 1916, p. 138).

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DESCRIPTION OF PLATE I.

FIG. 1.—*Nicella reticulata.* A part of a large colony stripped of its cœnenchym to show the arrangement of the anastomoses. Two-thirds natural size

FIG. 2.—*Caligorgia dubia?* The only fragment in the collection. It bears an epizoic Ophiuroid. A little larger than natural size.

FIG. 3.—*Stenogorgia sewelli* n. sp. A terminal branch of Specimen A.

FIG. 4.—*St. sewelli* n. sp. A terminal branch of Specimen B.

FIG. 5.—*Menacella sladeni.* Half natural size.

FIG. 1.

FIG. 5.

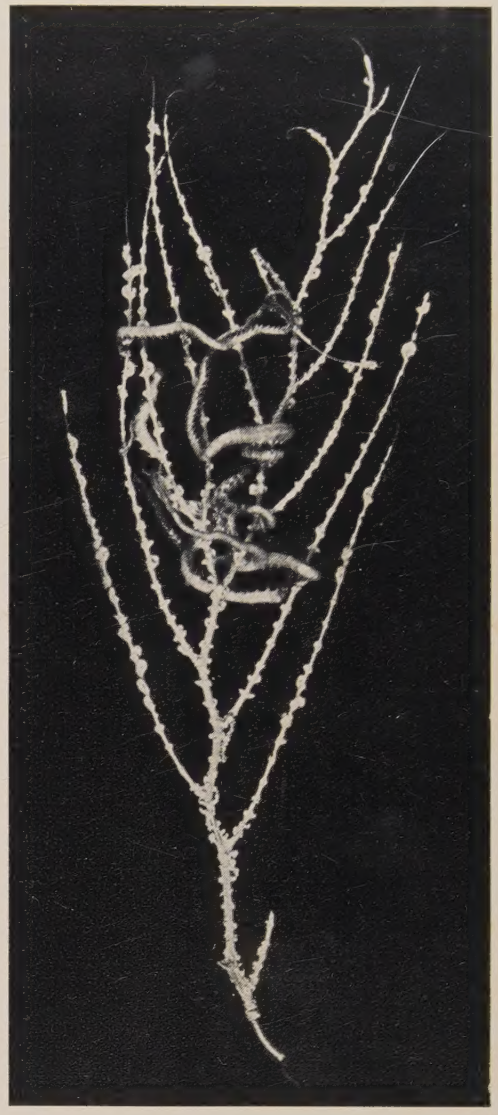

FIG. 2.

FIG. 3.

FIG. 4.

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